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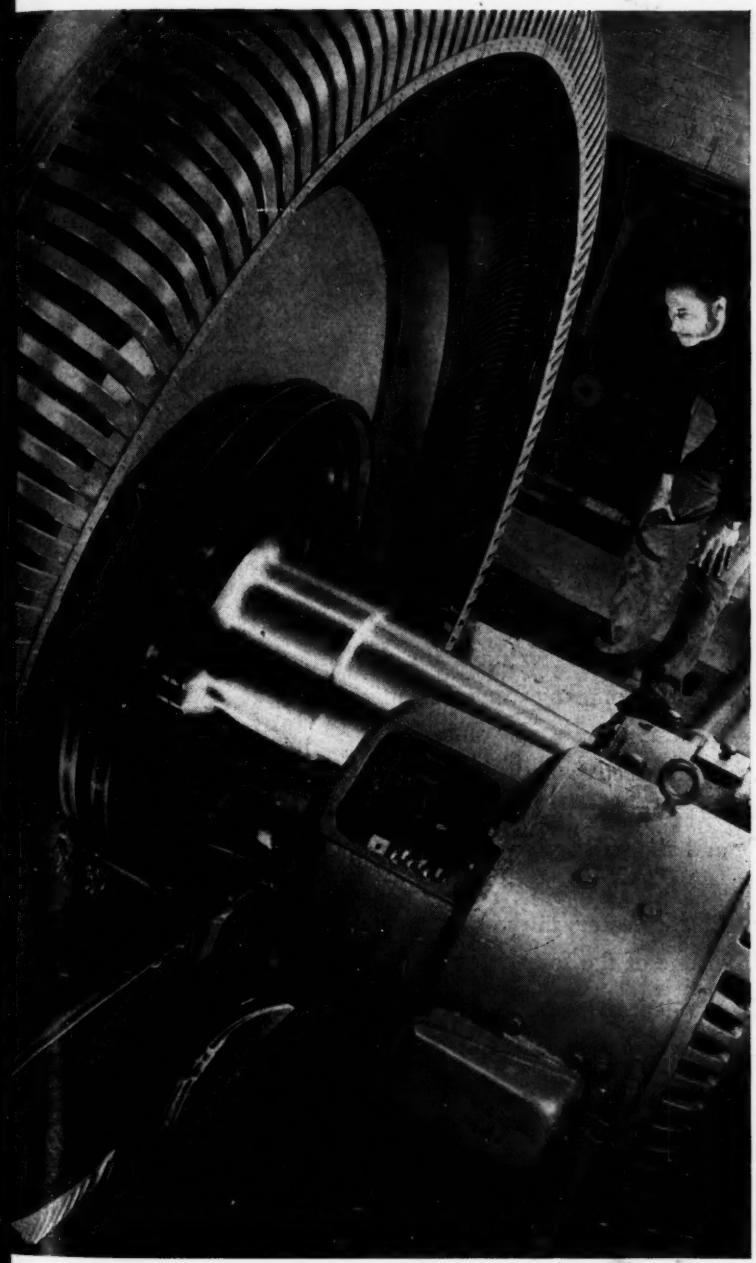
Power Generation

and POWER PLANT ENGINEERING



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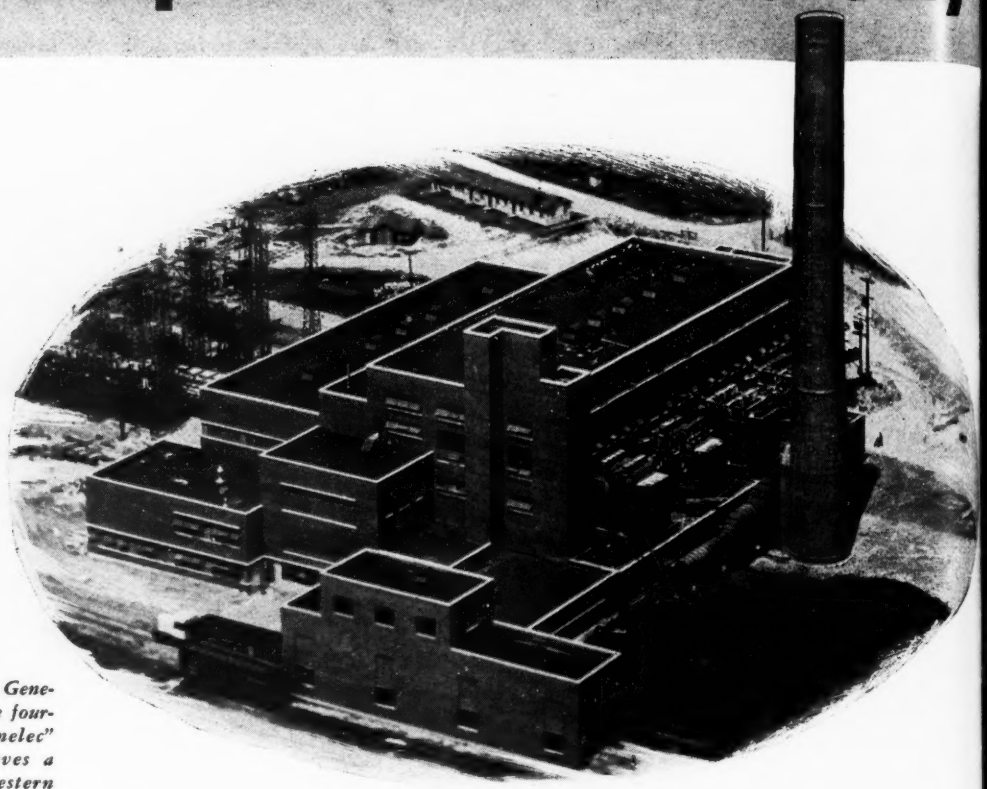
COVER: View of 1875-kw Allis-Chalmers generator driven by 2400-hp Nordberg diesel engine, installed in power house of City of Marshall, Mich. Unit started operating April 21, 1948. (Allis-Chalmers photo).

or Power Engineers Responsible for Supply of Steam, Electricity and All Other Power Plant Services

The new PENELEC Warren Station enjoys the protection and economy of



The new Warren Generating Station is the fourteenth in the "Penelec" system, which serves a major part of western Pennsylvania.

THE FIRST of two 35,000-kw units for this fine new station of the Pennsylvania Electric Company went into operation last September. The second 35,000-kw unit will soon be on the line. Both units will be served by Elliott deaerating feedwater heaters and deaerating evaporator preheaters. Thus the steam handling equipment in the entire plant—boilers, valves, piping and all auxiliary equipment—is guarded against corrosion by supplying oxygen-free feedwater to the boilers. The deaerating units also serve as efficient heaters in the heat balance cycle, steam being supplied them from one of the four extraction stages of the turbine.

In addition to deaerating heaters, Elliott equipment in the Warren Station includes two 30,000-sq ft surface condensers, with auxiliaries, and various twin strainers.

Reg. U.S. Pat. Off.

Elliott COMPANY

Deaerator & Heater Dept.,
JEANNETTE, PA.

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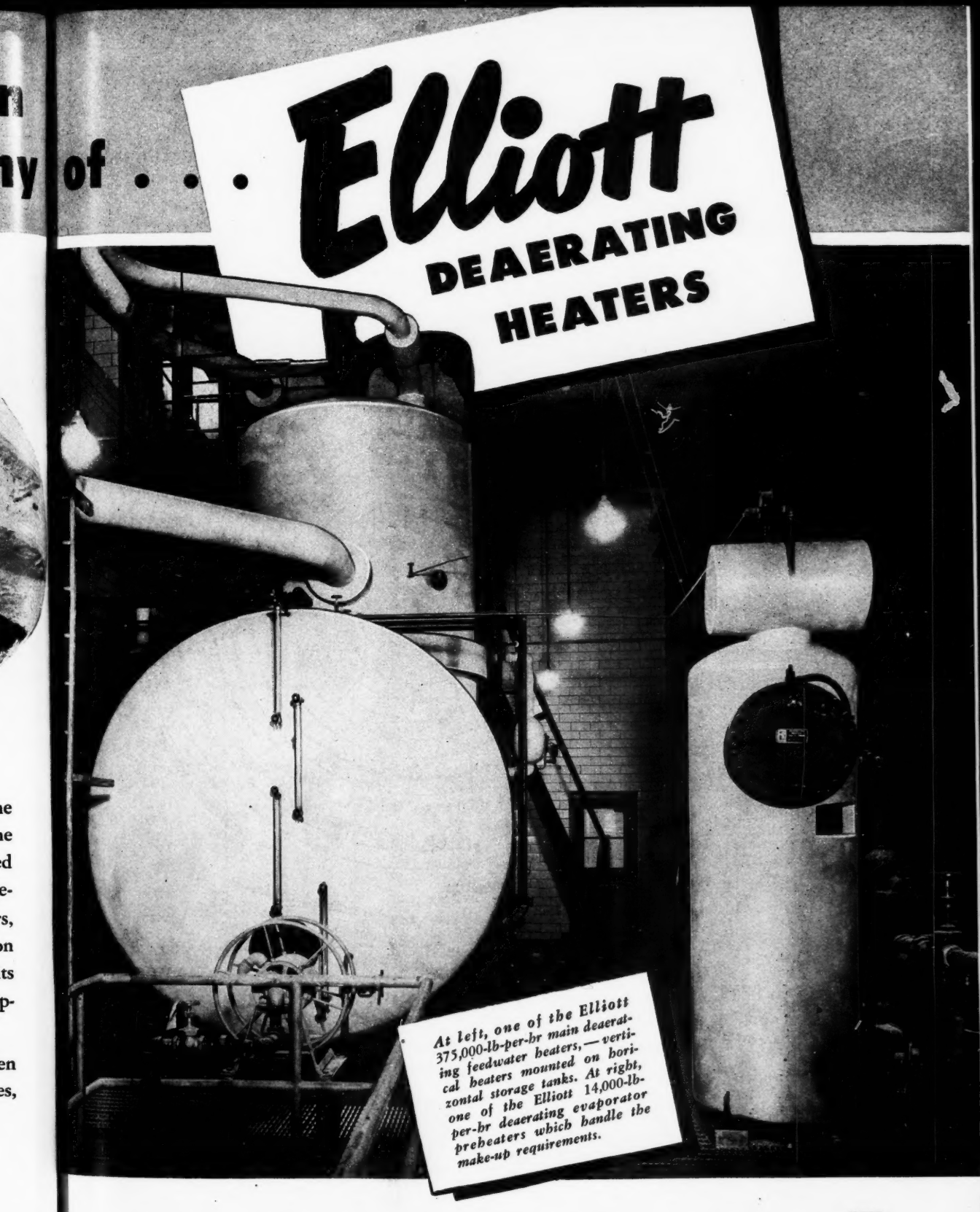

At left, one of the Elliott 375,000-lb-per-hr main deaerating feedwater heaters,—vertical heaters mounted on horizontal storage tanks. At right, one of the Elliott 14,000-lb-per-hr deaerating evaporator preheaters which handle the make-up requirements.

N-995

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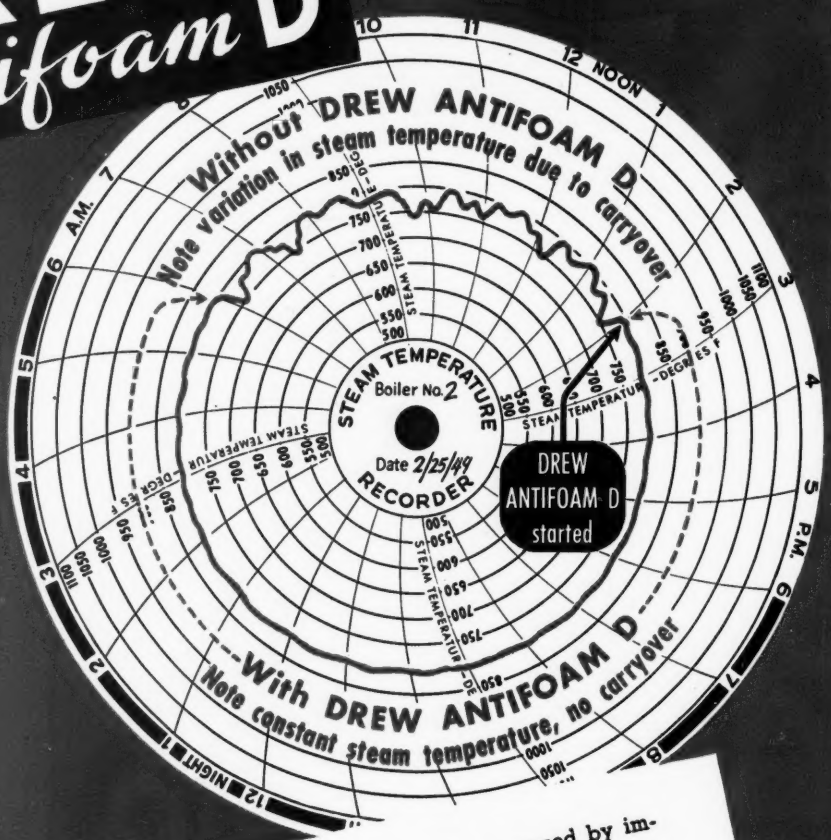
STOP BOILER FOAMING and CARRYOVER WITH

DREW *Antifoam D*



Carryover of moisture and solids with steam may be caused by improper chemical conditions in boiler water. In addition to heat losses, carryover causes steam line, superheater and turbine deposits.

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Power Generation

April 1949

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Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

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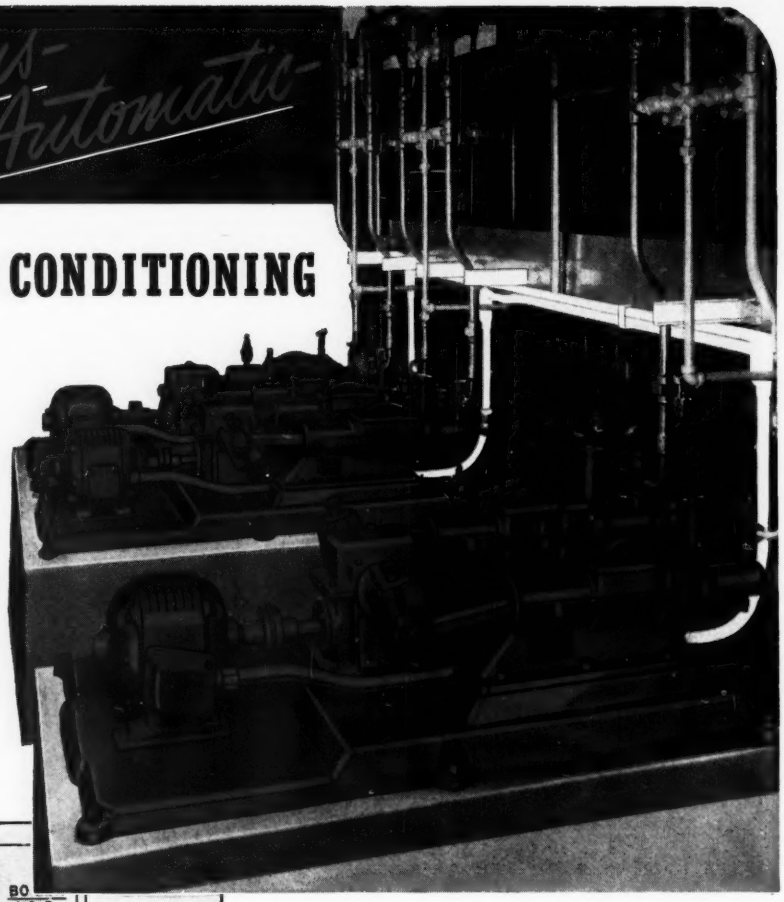
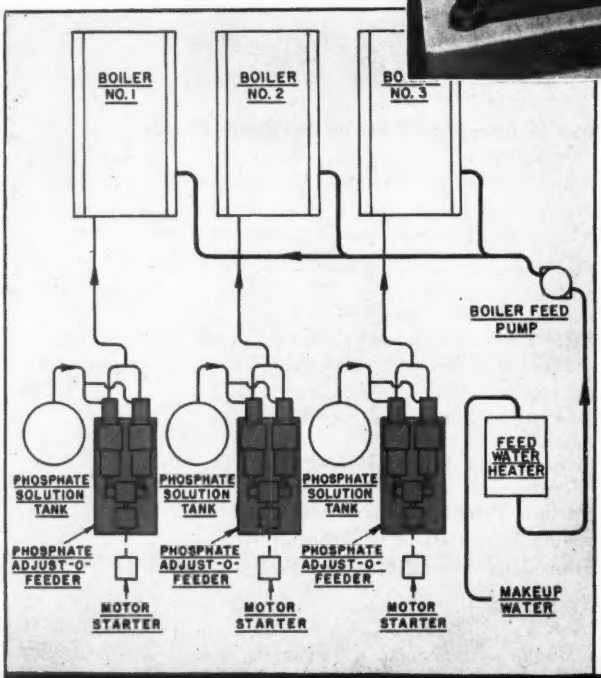
Continuous-Automatic-

BOILER WATER CONDITIONING



%Proportioneers% Equipment feeding phosphates to boiler water, United Illuminating Co. (Steel Point Station), Bridgeport, Conn. All equipment shown red in photo and flowgram furnished by %Proportioneers, Inc.%.



An adequate and regular method of injecting boiler water conditioning chemicals is a requisite in the modern power plant to prolong the life of its equipment, operate boilers at top efficiency with minimum fuel and avoid costly shutdowns for repairs and cleaning. The %Proportioneers% system adds the proper treating chemical, in the correct proportion at the right time.

Make use of the experience of America's leading chemical feeding engineers and proportioning specialists, gained in over 26,000 installations. Send details today for the complete analysis of your specific problem.

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ENGINEERS' PREVIEW

DR. SMITH'S SOLUTION of the inverted check problem, in the February E.P., page 8, certainly started a chain reaction or tripped a relay or pulled a trigger—or some'p'n. Below are just a few of the answers that have come in since the brethren saw Dr. Smith's comments. We can't possibly publish all of them, but these will show some of the methods of attack.

(You remember, a man cashed a check in a bank for X dollars and Y cents; the teller mistakenly paid him Y dollars and X cents. The man spent $3.50 and then found he had left twice as much money as the check originally called for. Find X and Y.)

C. E. Ellsworth says Dr. Smith's solution of the inverted check problem is entirely rigorous, but incomplete and—lapsing into current vernacular—"done the *hard* way." Therefore, in lieu thereof; we offer our own solution, as follows:

X=14 may not be the only solution to this problem; hence, to insure a complete solution, further cut and try operations, similar to those already performed by Dr. Smith, would be required up to X=47, Y=99.01 at least. This would mean much additional unnecessary labor on top of that indicated as already performed. Most of this labor can be avoided; as the following treatment of the problem will show:

$100Y + X - 350 = 2(100X + Y)$; whence:

$$Y = 2\frac{3}{98}X + 3\frac{56}{98}$$

Then $\frac{3X}{98} + \frac{56}{98}$ must be a whole number; that is, $3X + 56 = 98$ or some multiple of 98, resulting in $X = 14$ for 1×98, mixed numbers for 2×98 and 3×98, and $X = 112$ for 4×98. However, the value of X cannot exceed 99 cents; hence $X = 14$, $Y = 28\frac{42}{98} + 3\frac{56}{98} = 32$, is the only possible solution to the problem.

Baton Rouge, La.

C. E. Ellsworth
Engineer and Mathematician

I think your readers might be interested in a nice two equation solution to the Brain Teaser, says S. Robert Browar, and here it is.

I believe it is unnecessary to explain the formulation of the first equation needed to solve the problem.

X = dollars Y = cents of the check.

Equation 1: $100Y + X = 2(100X + Y) + 350$.

Formulation of the second equation needed:

a. X and Y must be integers, not fractions.

b. Y cannot exceed 99 (maximum cents possible).

c. X, being less than half of Y, must be less than 50.

d. Therefore, when the man spent $3.50 of the Y dollars and X cents he received from the bank, he must have diminished the Y dollars by 4, since he had only X (less than 50) cents.

e. We can then formulate $Y - 4 = 2X$, since he had Y dollars, made a $3.50 purchase, and still had 2X dollars left. This we shall call Equation 2: $Y - 4 = 2X$. (This formula must be correct unless Y is greater than 50, in which case twice X dollars and Y cents would be $2X + 1$ dollars and a small amount of cents, in which case we get Equation 2A: $Y - 4 = 2X + 1$).

The simultaneous solution of Equations 1 and 2 gives the answers $X = 14$ and $Y = 32$.

The simultaneous solution of Equations 1 and 2A gives fractional values of X and Y, which is impossible.

Thanks for the mental exercise.

Chicago, Ill.

S. Robert Browar
Chemical Engineer
National Aluminate Corp.

There is a far simpler solution to the $X and Y¢ check problem than the one given in your February issue, says A. B. Stickney. It is to separate the dollars and cents to get two equations.

On cents, since Y is greater than X, when we subtract 2Y cents from X cents, we must borrow a dollar and subtract 2Y cents from X + 100 cents. This gives us

$X + 100 - 2Y = 50$, or $X - 2Y = -50$, or $X = 2Y - 50$

Then on dollars, we subtract 2X from Y — 1 (since we borrowed a dollar) and get 3 dollars, or $Y - 1 - 2X = 3$, or $Y = 2X + 4$.

Substituting the X value from the cents equation in the dollars equation

$Y = 2(2Y - 50) + 4 = 4Y - 100 + 4 = 4Y - 96$ or $3Y = 96$, or $Y = 32$.

Substituting this back into the cents equation

$X = 2(32) - 50 = 64 - 50 = 14$

Thus original check was for $14.32. It was cashed for $32.14. Money left after spending $3.50 = 2(14.32) = $28.64. $32.14 — $28.64 = $3.50.

Pittsburgh, Penna.

A. B. Stickney
Rust Engineering Co.

As Dr. Smith observes, a statement of the problem leads to linear equations whose number is one less than the number of unknowns, comments T. L. O'Neil. Concerning the unknowns, however, we know additionally that they are positive integers. Thus, this becomes a problem in indeterminate equations of the first degree and as such can be solved forma'ly. The attack is perfectly general for this type of problem, as follows:

The original check and the erroneous payment can be reduced to cents, to avoid decimals, as follows:

Original check was (100X + Y) cents

Erroneous payment was (100Y + X) cents

Then, by statement, the payment less 350 cents equalled twice the check, or: $100Y + X - 350 = 200X + 2Y$; and simplifying we have $98Y - 199X = 350$, where X and Y are integers.

Now divide throughout by the small coefficient, thus:

$$Y - 2X - \frac{3X}{98} = 3 + \frac{56}{98}$$

Therefore

$$Y - 2X - \frac{3X + 56}{98} = 3 \quad \ldots\ldots\ldots\ldots (1)$$

Since X and Y are to be integers, we must have

$$\frac{3X + 56}{98} = \text{integer}$$

Now choosing a multiplier to make the coefficient of X differ from a multiple of 98 by unity (33 in this case), we have

$$\frac{99X + 1848}{98} = \text{integer}$$

that is

$$X + 18 + \frac{X + 84}{98} = \text{integer}$$

and therefore

$$\frac{X + 84}{98} = \text{integer, call it P}$$

and $X = 98P - 84$ ..... (2)

By substitution in (1) we have

$Y = 199P - 167$ ..... (3)

By giving P any integral value we obtain integral values for X and Y that will satisfy the original equation:

P	X	Y
1	14	32
2	112	231
3	210	430 etc

Note that while values of P higher than 1 give apparently incorrect results, they do satisfy the conditions: a check for 112 dollars and 231 cents, paid out as 231 dollars and 112 cents would satisfy the terms of the problem, except that in practice you probably would never find a check written that way.

Fredonia, N. Y.

T. L. O'Neil
The Red Wing Co., Inc.

Other solutions, arriving just too late for this issue will appear next issue.

ESTABLISHMENT of two national centers of rocket and jet propulsion study and research, to be located at Princeton University in the east and California Institute of Technology in the west, has been announced jointly by Harry F. Guggenheim, president of The Daniel and Florence Guggenheim Foundation, Dr. Harold W. Dodds, president of Princeton University, and Dr. Lee A. DuBridge, president of California Institute of Technology. The new institutions will be known as Daniel and Florence Guggenheim Jet Propulsion Centers. Each will provide facilities for post-graduate education and research in jet propulsion and rocket engineering. They will emphasize particularly the development of peacetime uses of rockets and jet propulsion.

★ ★ ★

FEDERAL AID for the more than three billion dollars worth of war-postponed sewage treatment works and other installations which states and communities need in order to clean up the nation's waters was called "insurance against hasty, ill-advised construction" by General Philip B. Fleming, Washington, D. C., Administrator, Federal Works Agency, addressing a joint session of the American Society of Civil Engineers' Sanitary Engineering Division, the New York State Sewage Works Association and the American Water Works Association. Today more than 9,100 towns with over six million people living in them need complete sewerage systems, he said. In nearly 10,000 additional communities, where almost 80,000,000 people live, the sewage systems need improvement. Towns of more than 5,000 population need sewers—yet we actually have 81 which now lack sewers. Eight states—Califorina, Illinois, Michigan, Missouri, New Jersey, New York, Ohio and Pennsylvania—each need more than $100,000,000 worth of sewerage works. New York State, which requires something over $1,000,000,000, heads the list and accounts for almost 30 per cent of the national total.

These and other estimates furnished by the Public Health Service, said Gen. Fleming, show why this country needs more than 80,000 miles of sewers, at least 12,000 new treatment plants, and additions to some 1,000 existing treatment plants.

★ ★ ★

PROGRESS—phooey! Higher standing of living—horsefeathers! Our favorite swiping magazine, Sparling *Metrograms*, reports that their Mabel K was turning out some relics not long ago and ran across a newspaper of 1913 vintage. In it she found these items she thought might interest everybody:

Men's balbriggan underwear, per garment ..... 15 cents
Women's lisle dittoes ..... 25 cents
Women's pants, knee length, lace trimmed ..... 12½ cents
Women's Oxfords, vici kid ..... 98 cents
Brass bed, steel spring, cotton mattress $18.75

WANT ADS:

Shaving ..... 10 cents; Hair cutting ..... 15 cents
House wanted, 5 or 6 room, in Wilshire district, not over $3500.
Room and board, $5 to $7 a week; piano and veranda.
5-room flats, unfurnished ..... $17.50 a month

Higher standard of living in 1949? Yer fadder's mustache!

"HE IS ONE PERSON I simply won't do business with." Is that sentence acceptable in modern educated American speech? Never mind whether it is grammatically correct or not. Would you use it yourself? Or do you hear enough people use it so that you think it's all right? A great many people will tell you it is not only incorrect but almost immoral to end a sentence with a preposition. But that is only one of 19 sentences, all containing what the purists would consider errors, analyzed in a very interesting article on How Correct Must Correct English Be? by Norman Lewis, in the March 1949 issue of *Harpers*.

That first sentence reminds us of the story about Winston Churchill. It is reported that in a recent speech "Good Old Winnie" cut loose with a burst of impassioned oratory on behalf of his cause, but right in the middle of it, wrapped up in his ideas, he ended one sentence with a preposition. In reply to his speech, an opponent not only attacked Winnie's ideas but also criticized him severely for his grammatical lapse. At this point, Winnie turned his bulldog face upon his tormenter and cried out, "Sir, that is a criticism up with which I will not put!"

That in turn leads inevitably to the preposition story to stop all preposition stories—the one about the little boy who packed five of them in at the end of one sentence, like this: "Daddy, what did you bring that book I don't want to be read to out of up for?"

★ ★ ★

NEW USE for old printing plates, in shielding research workers in cosmic ray studies and other high energy radiation work, has been found at Cornell University's Laboratory of Nuclear Studies. Appropriately, the Laboratory has acquired 3000 lb of such plates from the *Physical Review*, a scientific magazine established at Cornell in 1893. Some of the plates date back to the original issue. We assume these plates are electrotype or stereotype plates containing various proportions of lead and not the ordinary engravings of zinc and copper combinations, from which many magazine illustrations are printed.

★ ★ ★

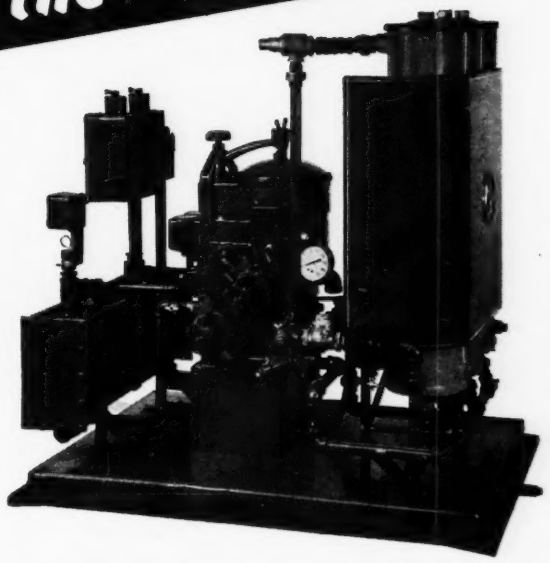
PLAN for automatic cost of living wage adjustments, as a contribution to the human side of management and management's obligation to the white-collar employee, has been advanced in Monograph 101, recently issued by Kerr & Co., Engineers. The monograph proposes a plan whereby management may follow an orderly, sound and constructive method in effecting periodical wage adjustments made necessary by increases or decreases in costs of living. Such adjustments are calculated upon a predetermined fixed base or salary value for each job. They follow up or down the consumers price index, as compiled by the Bureau of Labor Statistics. The monograph contains specific proposals for putting such a plan into effect, for establishing a base on a fair and reasonable basis, for selling the plan to both management and the employee, and for applying the automatic cost-of-living adjustments.

Whether this is the best or the only way to adjust your salary to costs of living, we do not presume to say. But it is a definite, specific plan and we have seen no others. It might be worth your while to look into it and, if it has not already been discussed, bring it to the attention of your company.

The monograph sells for $1.00 and if your company is interested, we'll tell you how to get one.

DIRT · WATER · CARBON

All removed by the "PURI-FILTER"



THE DE LAVAL "Puri-Filter" removes all three major contaminants of Diesel lubricating oil: dirt, water and colloidal carbon. The first two are separated from the oil by centrifugal force in the bowl of the De Laval Oil Purifier—the water being discharged continuously. The colloidal carbon is filtered out of the purified oil by the filters.

The De Laval "Puri-Filter" combines the De Laval "Uni-Matic" Oil Purifier and Fram "Filcron" Filters. Because the combination unit gets rid of all contaminants down to one micron in size, and likewise keeps the oil completely free of moisture, it is the most effective means ever devised for protecting Diesel engine bearings.

Crank cases remain clean when Diesel oil is "Puri-Filtered." Write for Bulletin DL-1, which gives additional details.

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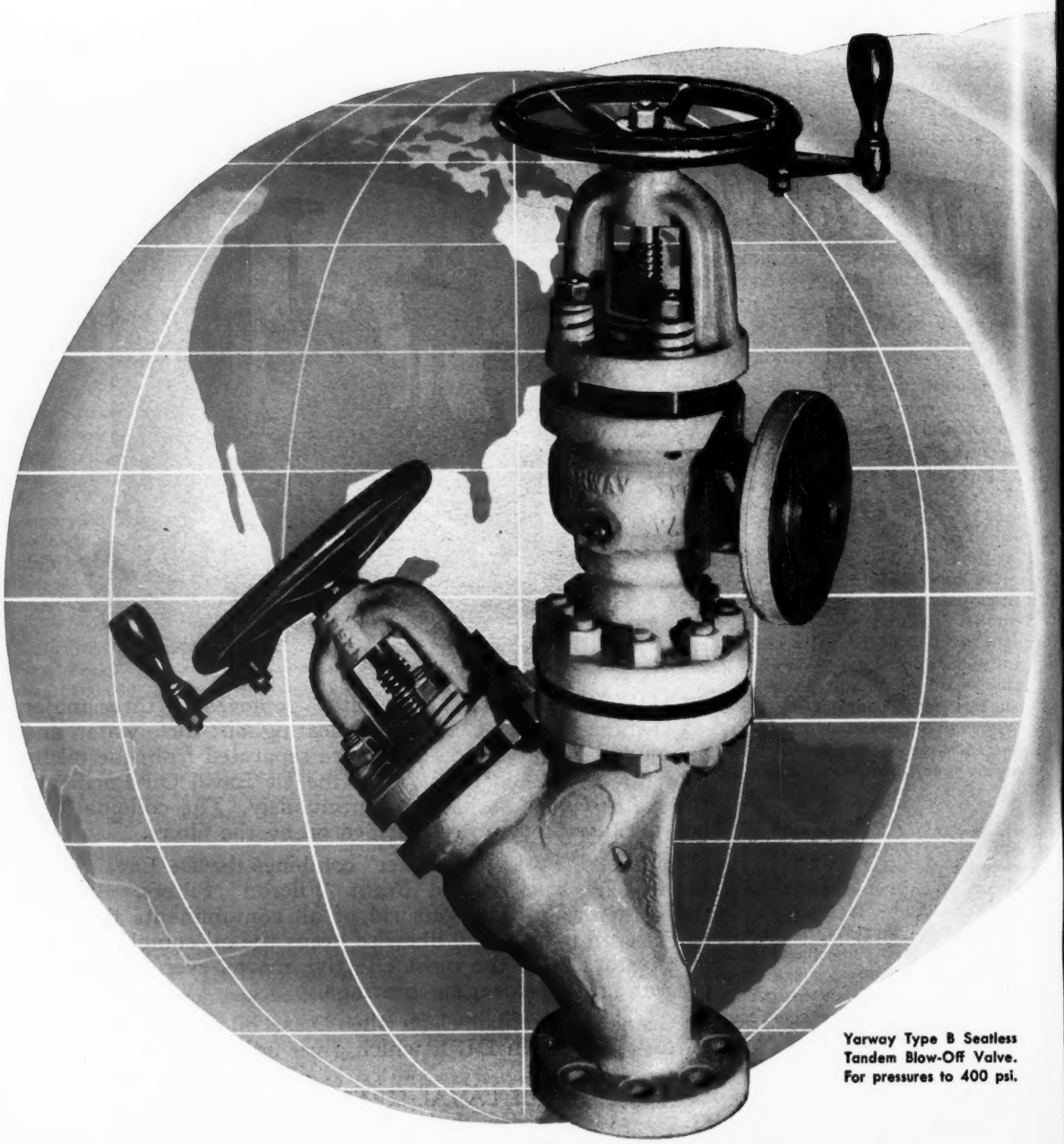
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL



Yarway Type B Seatless Tandem Blow-Off Valve. For pressures to 400 psi.

YARWAY

THEY KEEP BLOW-DOWN LINES TIGHT IN OVER 15,000 PLANTS

Yarway Blow-Off Valves are known in almost every plant where boilers are used to generate steam.

Why this thorough acceptance? Partly because the Yarway *Seatless* feature eliminates the commonest source of blow-off valve trouble. In Yarway *Seatless* Valves there are no seats to score, wear, clog and leak.

Partly because of Yarway's advanced designs—such as the Unit Tandem for high pressure work. This valve combines a Yarway *Stellite-Seat* Valve (for blowing) with a Yarway *Seatless* Valve (for sealing) in a solid, one piece forged-steel body.

And finally the dependable, trouble-free service of Yarway Blow-Off Valves prompts power plant engineers to insist on Yarways.

Regardless of the reason, the fact remains that today Yarway Valves are on the job—doing a good job—in more than 15,000 plants. How about yours?

Write for Bulletin B-424 for pressures to 400 psi. For higher pressures ask for B-432.

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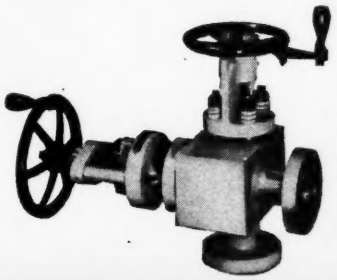
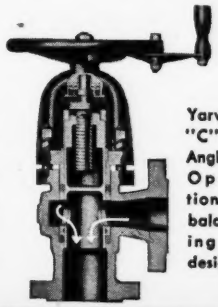
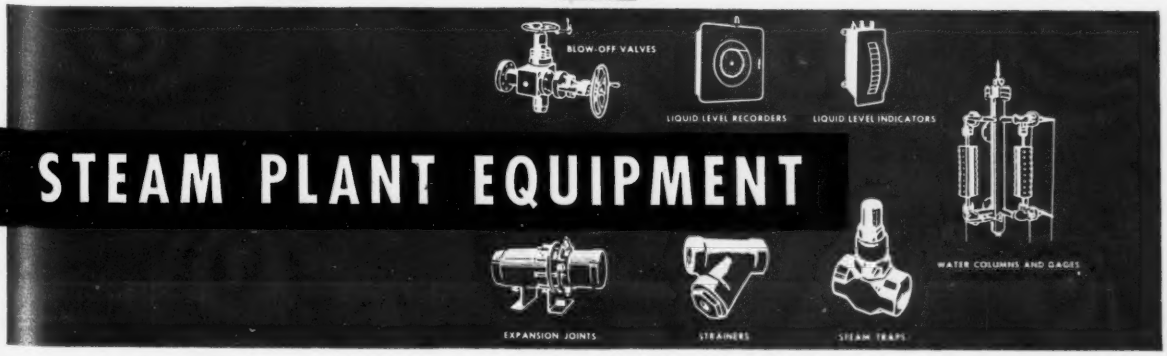


Yarway Unit Tandem Blow-Off Valve. Flanged type. Also available with welding ends. For pressures up to 2500 psi.

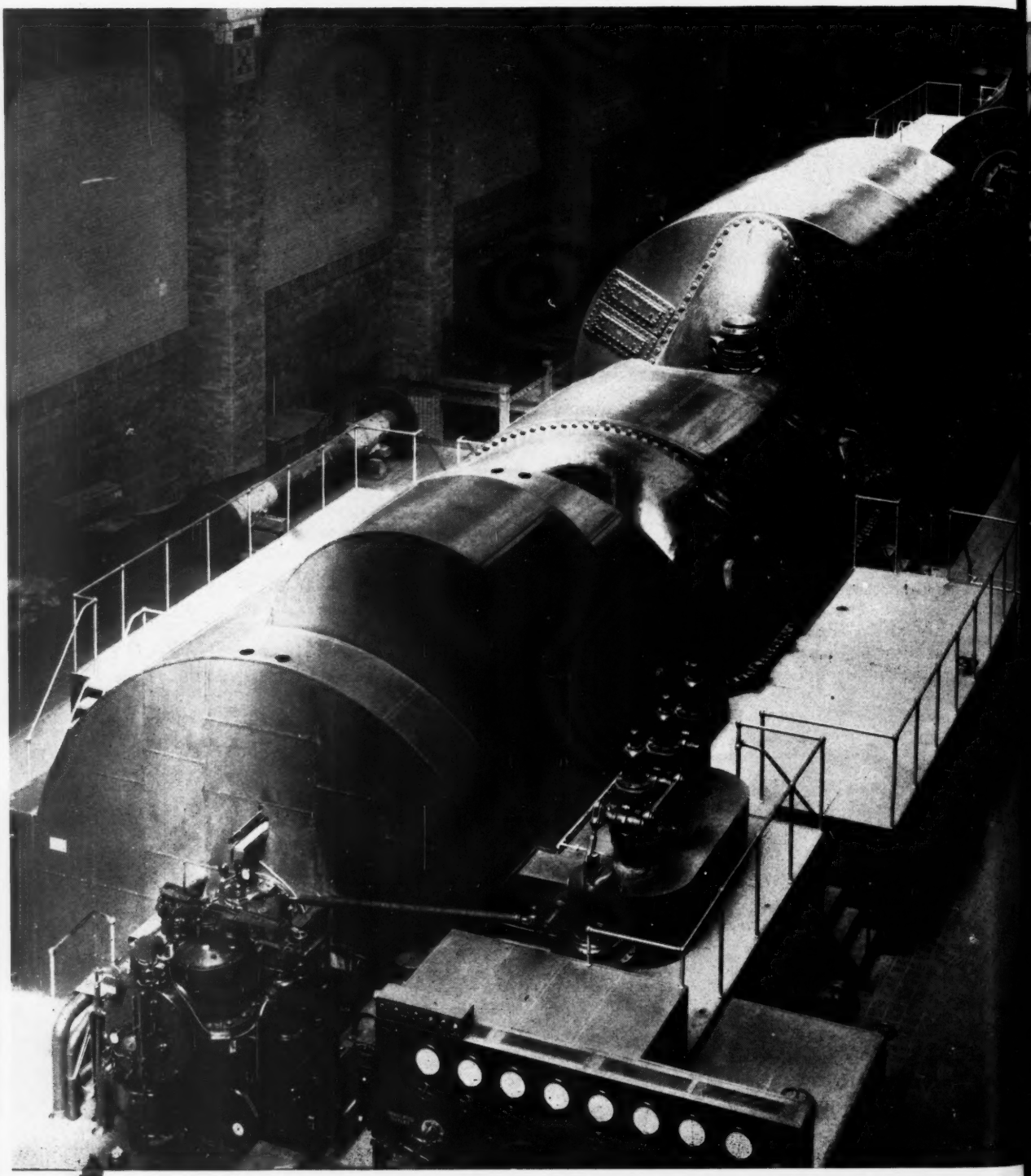


Yarway Type "C" Seatless Angle Valve. Open position. Notice balanced sliding plunger design.

Yarway Stellite-Seat Straightway Valve. Open Position.



160,000 KW... safeguarded agains



STANDARD OIL COMPANY (INDIANA

ins**outages by**

NONPAREIL
Turbine Oil

The two big turbines shown in the photograph at left have a total capacity of 160,000 KW. Outages for oil system maintenance have been eliminated on this large operation by Nonpareil Turbine Oil.

Oil acidity troubles have been avoided. The original fills of Nonpareil have not been removed for treating or resting in their respective five and six years of use. Nevertheless, neutralization numbers have stayed below 0.10 mg. KOH/gm.

Oil system maintenance has been eliminated. There has been no deterioration of the lubricant. The turbine oil systems have remained free from deposits.

Nonpareil Turbine Oil provides this protection against outages, not for 5 or 10 or 20 years, but for the life of every turbine it lubricates. It is the only product in its field that carries a written guarantee that it will last as long as your turbine, without increasing in acidity above a neutralization number of 0.15 mg. KOH/gm.

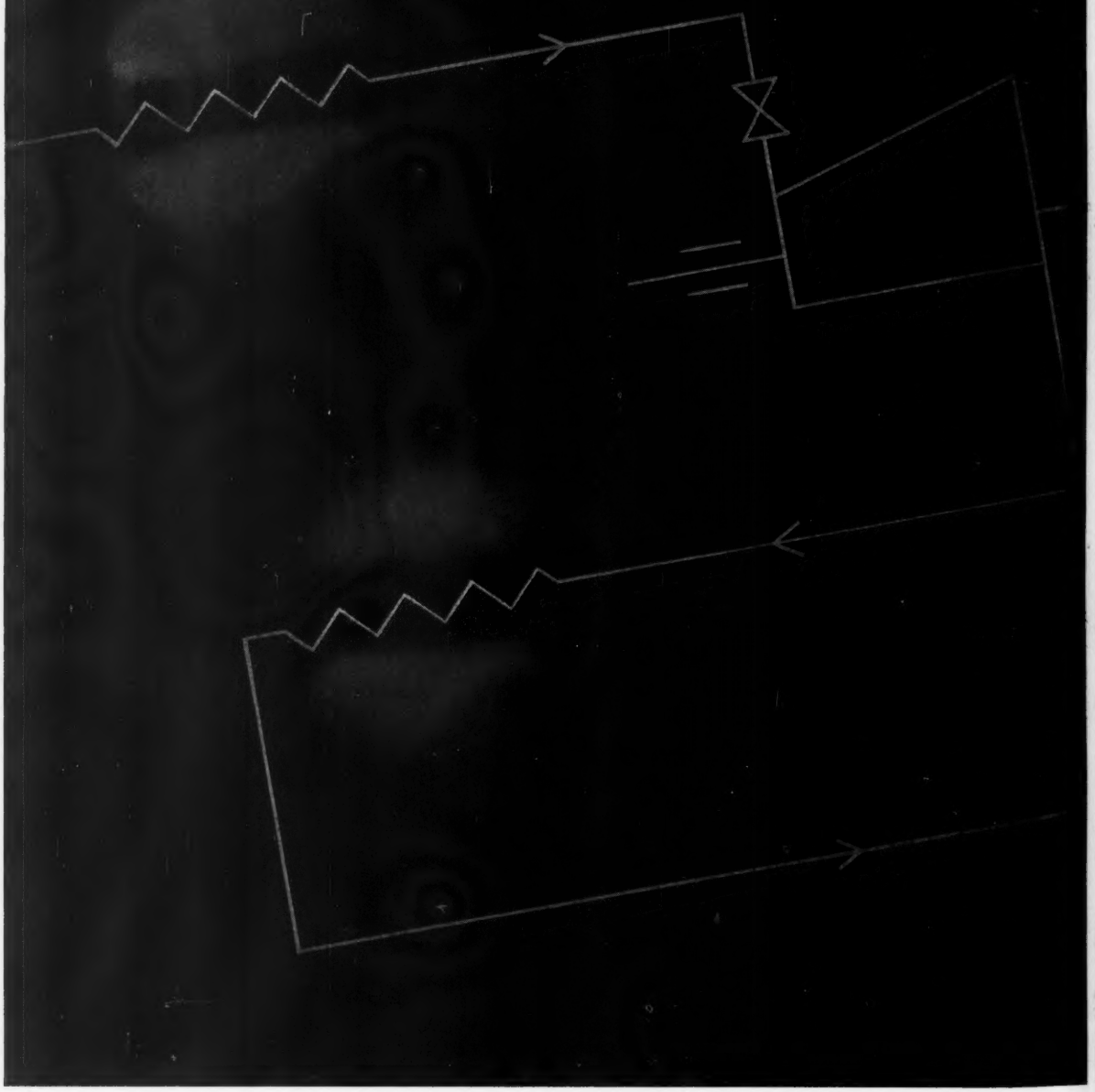
Why not end oil acidity troubles and oil maintenance once and for all, by shifting your turbines to Nonpareil Turbine Oil. If your plant is located in the Midwest, write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the services of the Standard Oil Lubrication Engineer nearest you.

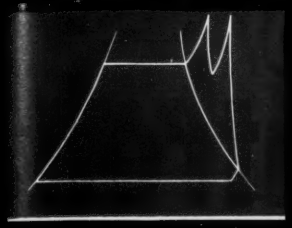
IANA **STANDARD OIL COMPANY (INDIANA)** STANDARD

steam generation – *an art*

RADIANT SUPERHEATERS AND RADIANT REHEATERS

...engineered and fabricated by Foster Wheeler, helped one midwest station earn the reputation for being the country's most efficient steam power plant.





The Foster Wheeler organization has devoted over fifty years to improving steam generation technique and steam power plant equipment. A few of FW's historical achievements are listed below:

- 1[illegible]0 — Pulverized fuel was developed on a commercially successful scale.
- 1[illegible]2 — Superheated steam was introduced commercially in the United States.
- 1[illegible]9 — Radiant superheaters were developed after long research and development.
- 1[illegible]4 — Water walls and water backs were applied to many types of furnaces burning various fuels.
- 1[illegible]0 — The first large steam generator in a utility plant to operate at 1000° F over a wide load range was installed.
- TODAY — All the engineering, manufacturing, and construction activities of the Foster Wheeler organization are geared toward helping build the better power plants of today and tomorrow.

FOSTER WHEELER CORPORATION · 165 BROADWAY, N.Y. 6, N.Y.

FOSTER WHEELER

Experience proved the value of

HAGAN Controls

at CROWN PAPER BOARD CO., Inc.

More than 25 years ago, Hagan Automatic Combustion Control was installed on three stoker-fired, natural draft boilers in the plant of Phil-Fibre Box Board Mills, in Philadelphia.

In 1933, these boilers were converted to oil, and the Hagan control system was modified accordingly. Expense of this modification, incidentally, was nominal. Records show continuous maintenance of 12-13% CO_2 with this old equipment.

The plant was sold to Crown Paper Board Co. in 1944, and the new owners undertook an extensive program of plant renovation. The largest of the old boilers, a 400 h.p. unit, was replaced in 1946 by a new 750 h.p. unit. Hagan Control was specified for this boiler. The instruments on the old boiler were used, and Hagan panel controls were added to the existing panel.

In 1947, another 750 h.p. boiler was placed in service, replacing the two 300 h.p. units. Again, Hagan Control was specified, and Hagan also supplied panel board and instruments, including a Hagan Ring Balance Steam Flow-Air Flow Meter. This meter was equipped with a third pen for recording stack temperature, and with an integrator which continuously totalizes steam flow.

After several months experience with the Hagan Control Panel and Ring Balance Meter on the new boiler, they ordered a new control panel, and an identical Hagan Ring Balance Boiler Meter for the older boiler.

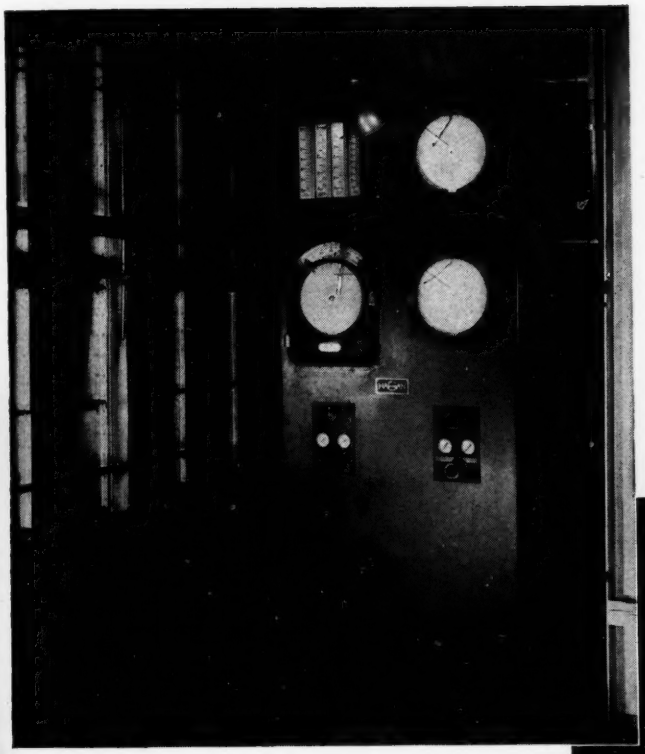
The new boilers operate at 160 lb. pressure. They are oil fired, one having a turbine driven forced draft fan and the other having a motor drive fan. Maximum continuous rating of each boiler is 45,000 lb./hr.

Load on these boilers normally ranges from 25,000 lb./hr. to 45,000 lb./hr. Occasionally breakage of paper in the mill causes a sudden drop in demand to 12,000 lb./hr. The controls adjust fuel-air ratio instantly, in accordance with demand, and meters follow the fluctuations accurately.

For full information on Hagan Combustion Control Systems and Hagan Ring Balance Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

The second of the two new boilers at Crown Paper Board was the first to have a new control panel with Hagan Ring Balance Steam Flow-Air Flow Meter.

and Meters



After the second boiler was placed in service, a new panel was installed for the first boiler, and this also was equipped with a Hagan Ring Balance Meter.

New boiler plant at Crown Paper Board. Consulting engineers were the Stewart A. Jellett Co., and contractor was John C. Kohler, both of Philadelphia. Crown's plant renovation program, of which this is a part, is directed by R. S. Brookover, General Manager.

HAGAN
HALL
BUROMIN
CALGON

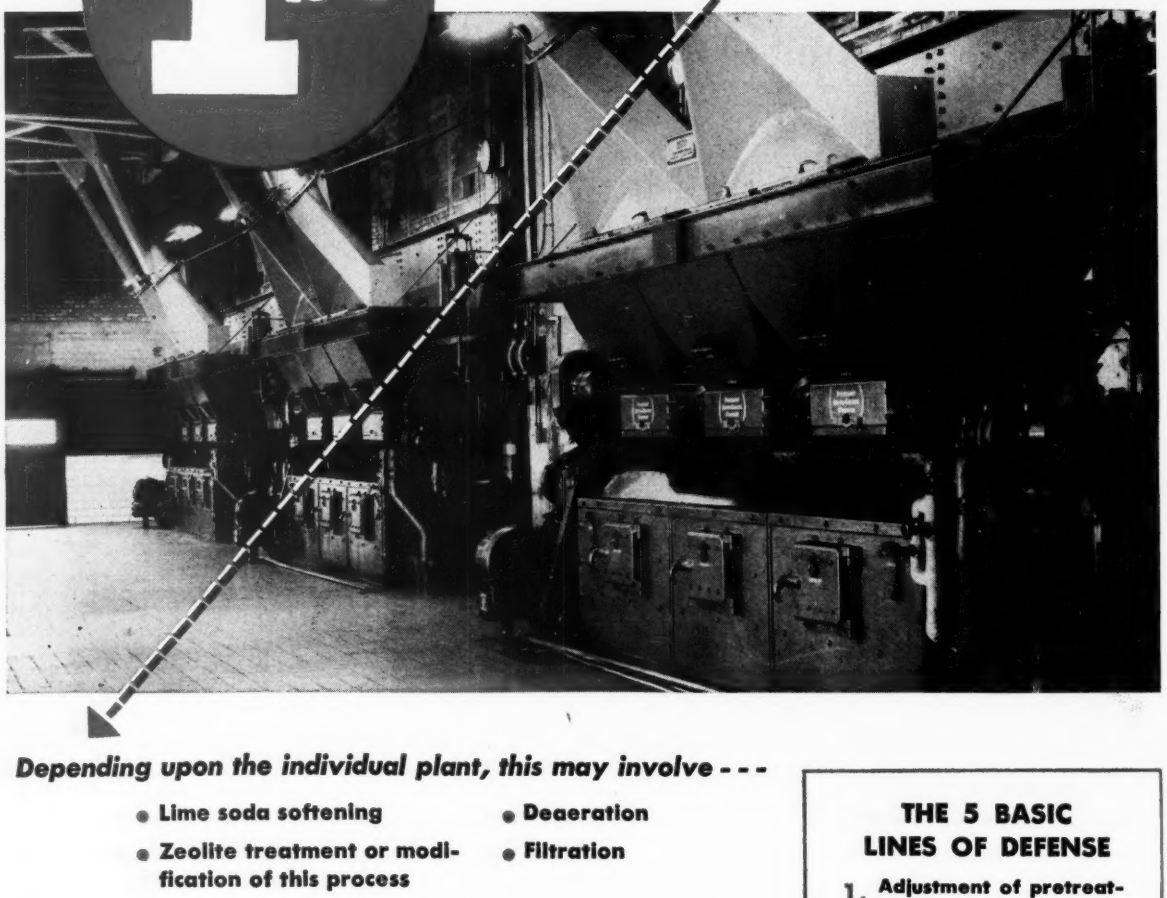
HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

BASIC LINES OF DEFENSE
IN BOILER WATER CONDITIONING

1st

The first line of defense in the boiler water conditioning program is the adjustment of pretreatment



Depending upon the individual plant, this may involve - - -

- **Lime soda softening**
- **Zeolite treatment or modification of this process**
- **Deaeration**
- **Filtration**

The Dearborn Engineer is qualified to confer with you in solving these problems and establishing the correct procedure for operation and control. This is a part of Dearborn Service. Whether or not pretreatment operations are needed in your plant, the combination of Dearborn Treatment and Engineering Service will solve your water treating problems.

To establish correct boiler water conditioning in your plant, all five lines of defense must be given expert consideration.

THE 5 BASIC LINES OF DEFENSE

1. **Adjustment of pretreatment**
2. **Adjustment of internal treatment**
3. **Proper means for treatment application**
4. **Blowdown adjustment**
5. **Test control**

Dearborn
Reg. U.S. Pat. Off.

THE LEADER IN BOILER WATER TREATMENT AND RUST PREVENTIVES

DEARBORN CHEMICAL COMPANY

310 S. Michigan Ave., Chicago 4 • 807-15 Mateo St., Los Angeles
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The "rains" came . . . and packing problems were solved

[redacted]

A lead-based, anti-friction metal is used that will withstand temperatures well over 1200° Fahr. (temperature tests by University of California). Proportionate with the metal units are materials of a heat-resisting nature to substitute for the wood units of the standard packing . . . thus giving resiliency to the packing and at the same time prevents the packing from forming a solid under excessive pressure. Both materials being treated separately with special lubricants and graphite depending upon the job. Withstands all pressures and temperatures.

[redacted]

Caustic
Acids (state kind)
Gas and Oil (petroleum solvents)
Alcohol (pure and mixed)
Paint Pump
Food Products
Below zero temperatures
special requirements (made to order)

Specially treated so that the dissolving action of the liquid does not affect the packing. The packings are broken in with the pumps running idle; producing a sealed-in lubricated bearing formation, thus protecting the shaft from the corrosive effect of the material handled.

[redacted]

RAINS STANDARD PACKING is used on all the ordinary services found in the average industrial or power plant . . . on either reciprocating or rotary motion rods, stems and shafts . . . on pressures to 10,000 pounds; temperatures to 400° Fahr.

On pumps . . . hot and cold water, brine, asphalt, creosote, sewage, and other services.

All saturated steam services
Hydro-electric equipment
Air compressors and pumps
Presses, accumulators, hydraulic pumps
Refrigeration equipment
Valves

PROOF

On the primary control valves of a 36,000 KW, G.E. turbine, 250 pounds pressure, 625° Fahr., total temperature, RAINS SUPERHEAT PACKING outlasted the leading conventional types of packing 18 times. One engineer states: "Complete satisfaction with the various packings used in the past on 550 pounds pressure has not been attained . . . with RAINS SUPERHEAT PACKING there was no leaking and no binding.*

PROOF

Hot Sulphuric Acid Pumps at large paper mill packed with RAINS SULPHURIC ACID PACKING have given 26 months of service without maintenance costs. Conventional type packings lasted from a few weeks to 4 months and were always in danger of suddenly disintegrating and spilling acid over bearings, causing $200 to $300 damage as well as expensive man hours in repair work.*

PROOF

Boiler feed pump service is considered one of the hardest of the ordinary services to hold because of the drying out of conventional packings due to heat and effect of boiler compounds. THREE OR FOUR MONTHS IS AVERAGE LIFE OF CONVENTIONAL PACKINGS. RAINS PACKINGS ON THE SAME PUMPS IS STILL IN OPERATION AFTER FIVE YEARS OF SERVICE . . . same rods and shafts, same packing.*

SIMPLE INSTALLATION

RAINS PACKINGS are broken in to form a self-lubricated, bearing-like wearing surface next to the rod or shaft.

Lantern or seal rings are removed.

If openings in bottom of box are large, metal choke rings are recommended. Cut rings from coil and tamp each ring into box separately with wooden stick and hammer until completely full. Tighten gland. Add another ring if possible. Keep tightening gland at regular intervals, never permitting packing to leak. The packing will heat, but keep tightening. After it is broken in and the bearing is established to the point of a frictionless operation, it will cool off and run much cooler than conventional packings.

*AFTER 30 DAYS, TEST PUMP FOR INCREASED OUTPUT by comparison with previous packings used.

Distributors located in principal U. S. and Canadian cities.

RAINS WOOD-METAL PACKING

904 W. Broadway, Spokane, Washington, U. S. A.

*PROOF on any type of pump will be furnished on request.

When ordering new Equipment . . . Specify RAINS PACKINGS

Alabama Pulp & Paper Co. Allied Chemical & Dye Corp. National Aniline Div. **Solvay Process Div. Altos Hornes de Mexico

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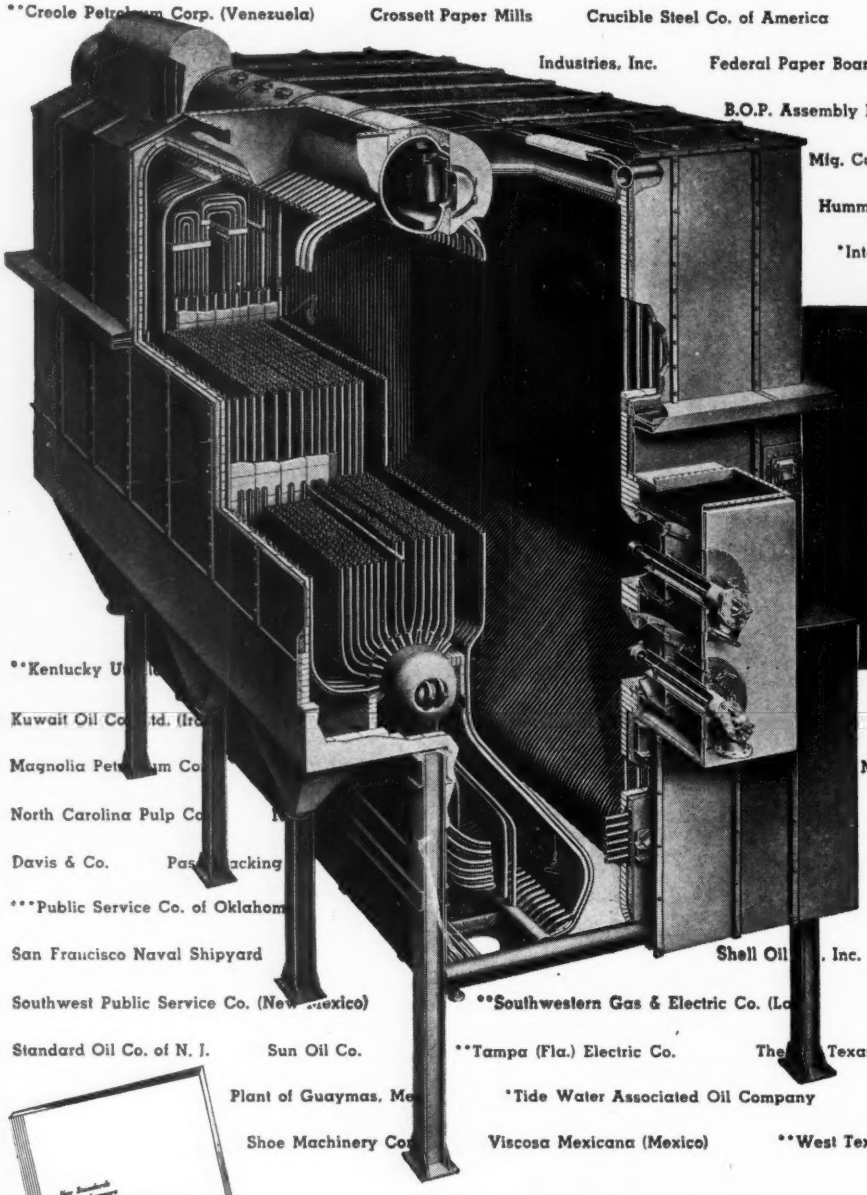

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**Kentucky U

Kuwait Oil Co. Ltd. (Ir

Magnolia Pet m Co

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Davis & Co. Pas acking

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San Francisco Naval Shipyard

Southwest Public Service Co. (New Mexico)

Standard Oil Co. of N. J. Sun Oil Co.

Plant of Guaymas, Me

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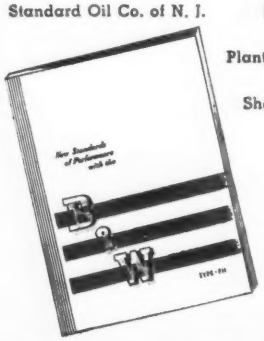
Southwestern Public Service Co. (Texas)

**Tampa (Fla.) Electric Co. The Texas Co. Texas Power & Light Co.

*Tide Water Associated Oil Company Tucson (Ariz.) Gas & Electric Co.

Viscosa Mexicana (Mexico) **West Texas Utilities Co. *Wisconsin Power &



Worth looking into NOW
for low-cost steam TOMORROW

Send for Bulletin G-38 describing and illustrating features and showing typical applications of the Type FH boiler.

American Cyanamid Co.—Calco Chemical Div. American Enka Corp. American Potash & Chemical Corp. American Tobacco Co.

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In meeting new needs for steam for power generation, heating and processing purposes, a fast-growing number of industries and power companies are finding the ideal answer to their requirements up to 300,000 lb. per hr. in the • • •

ng friends *fast!*

TYPE FH INTEGRAL-FURNACE BOILER

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*Repeat orders to date.

An important advance in steam engineering, this latest B&W unit brings together in a modern standardized design all the best features of the original and highly successful Integral Furnace Boiler introduced by B&W 14 years ago, plus many additional improvements . . . each one time-tested and performance-proved in other types of B&W units.

Immediate and widespread acceptance—over 35 million pounds per hr. of steam capacity installed or ordered in less than 4 years—is evidence that the type FH Boiler satisfies all modern requirements for dependability, efficiency, accessibility, flexibility, and economy of installation and operation.

The advantages of standardization are made available in three general classes of Type FH Boilers which provide the variations in furnace size and arrangement of heating surface necessary for reasonable latitude of application. The available range covers pressures up to 1050 psi and temperatures to 910 F.

It will pay you, as it has so many others, to consult B&W engineers about this boiler when planning a new power plant or modernizing present power facilities.

G-436

THE BABCOCK & WILCOX CO.

General Offices: 85 Liberty Street, New York 6, N. Y. Works: Alliance and Barberton, O.; Augusta, Ga.

FOR POWER PLANTS—B&W Open-Pass, Radiant, Integral-Furnace, Cross-Drum, Stirling and Waste-Heat Stationary Boilers . . . Air Heaters . . . Economizers . . . Superheaters . . . Water-Cooled Furnaces . . . Oil, Gas & Multifuel Burners . . . Chain-Grate Stokers . . . Stacks and Breechings . . . Seamless & Welded Tubes for All Pressure and Mechanical Applications . . . Refractories . . . Chemical Recovery Units . . . Alloy Castings.

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OTHER B&W PRODUCTS—Marine Boilers . . . Pressure Vessels . . . Process Equipment.

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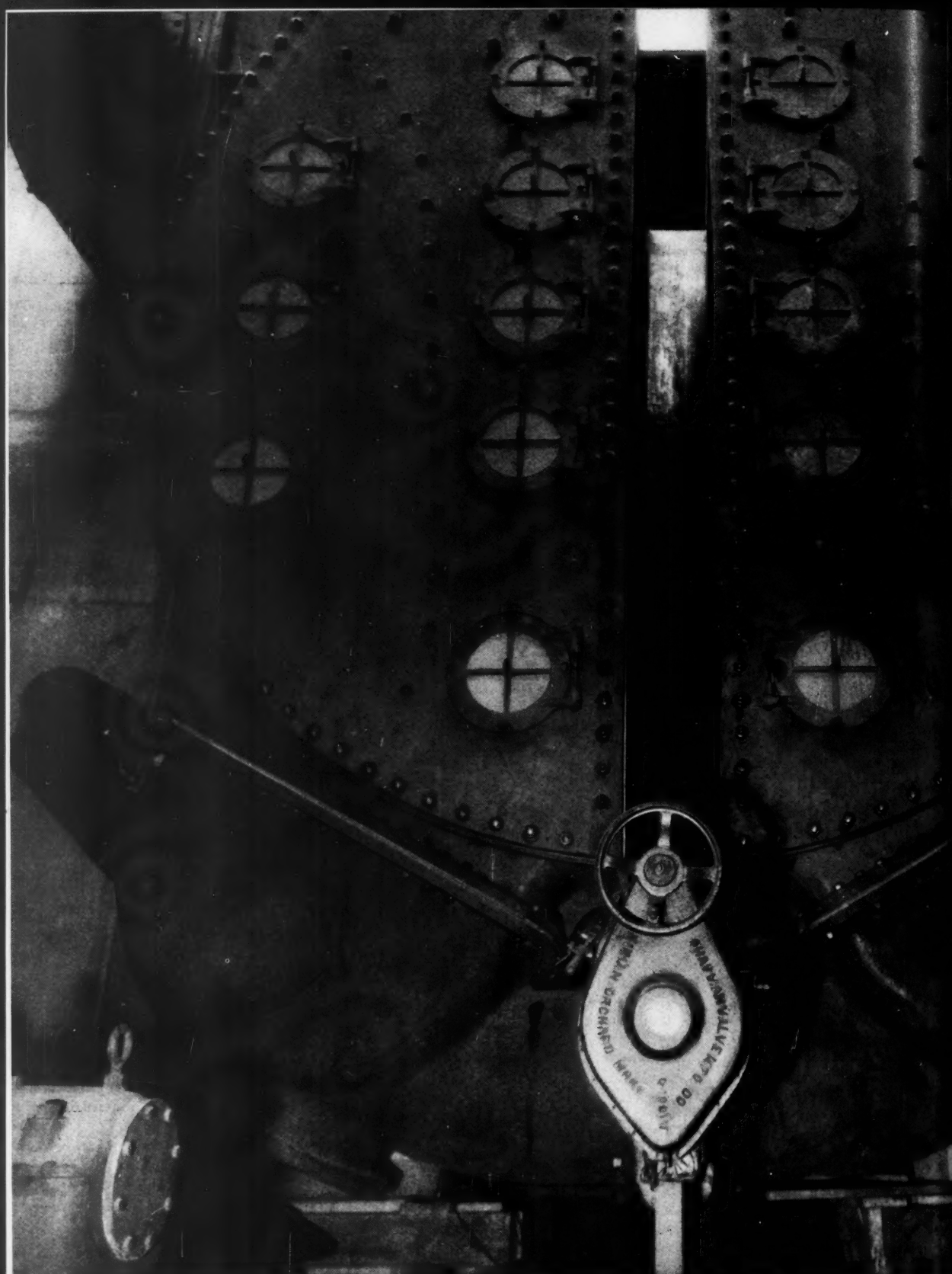

C. H. Wheeler

EA
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50,000 Sq. Ft., 2 Pass Reverse Flow Condenser

Under 60,000 K. W. Steam Turbine

A certain large public utility (name on request) faced the problem of leaves, trash and other refuse in their only available supply of condenser circulating water. They could have installed a standard condenser, but they found many advantages, including money saving, in selecting a C. H. Wheeler Patented "Reverse Flow" Condenser. Periodic reversal of water flow automatically cleans the tubes and tube sheets of this condenser, without loss in efficiency. Installation was simplified with the C. H. Wheeler "Reverse Flow" because it does not require any additional piping over that of a standard condenser. Photo shows this installation nearly completed. Note the two C. H. Wheeler Circulating Pumps which partly show in the foreground; also the Cross Over Valve for operation with one circulating pump. Condenser is equipped with C. H. Wheeler Steam Jet Ejectors and C. H. Wheeler Condensate Pumps. Write for more information about "Reverse Flow" or Standard "Dual Bank" Condensers, described in Catalog No. 1461.

C. H. WHEELER MANUFACTURING CO.

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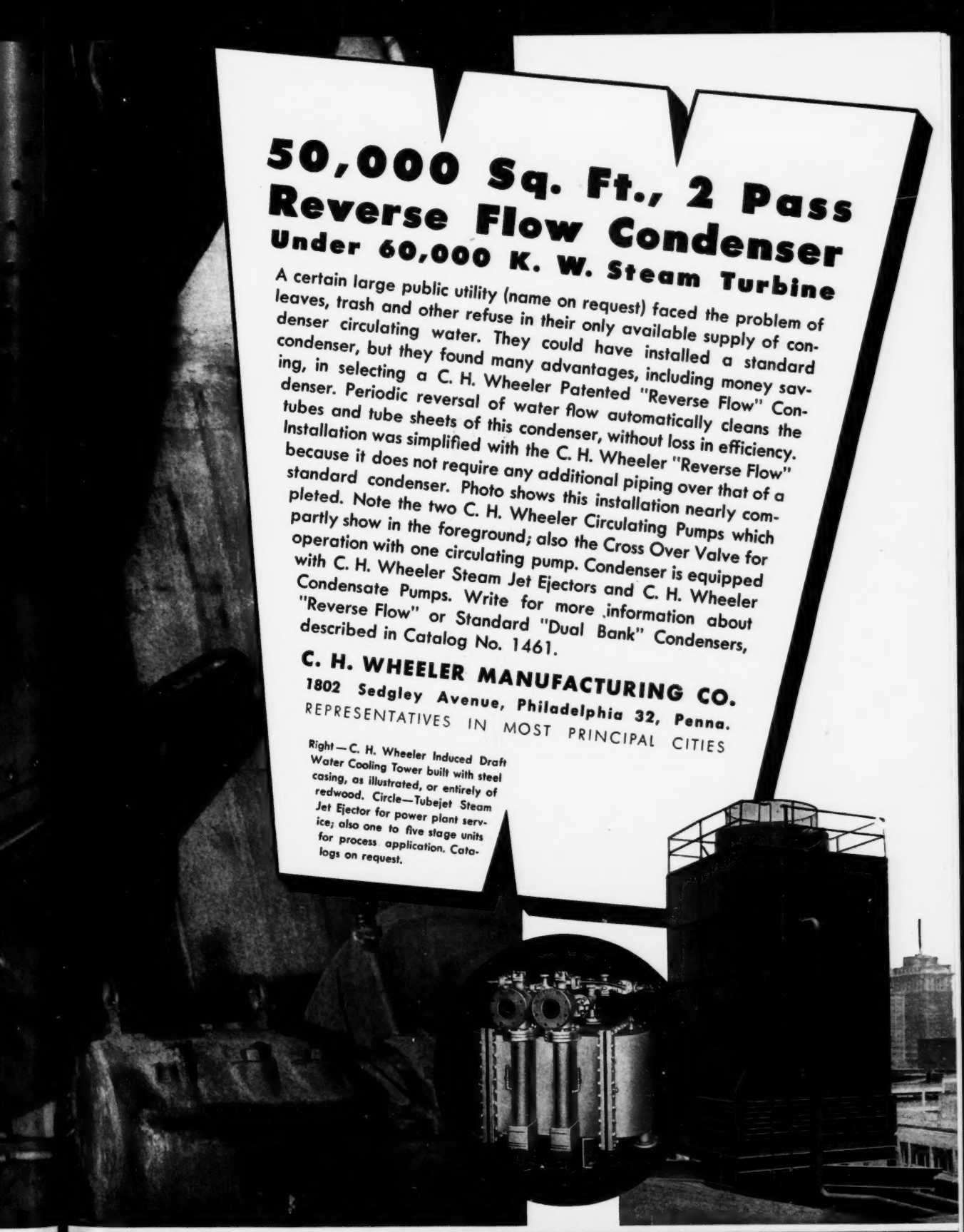
REPRESENTATIVES IN MOST PRINCIPAL CITIES

Right—C. H. Wheeler Induced Draft Water Cooling Tower built with steel casing, as illustrated, or entirely of redwood. Circle—Tubejet Steam Jet Ejector for power plant service; also one to five stage units for process application. Catalogs on request.



EAM CONDENSERS • WATER COOLING TOWERS
ECTORS • STEAM JET VACUUM REFRIGERATION
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Is a Standardized Boiler Unit THE BEST ANSWER for your steam needs?

Sure—your plant is different. Your combination of load, pressure and temperature requirements, fuel situation and physical layout — when put together — probably poses a problem different from that of any other plant in the country. *But* — can all these variables be met by a steam generating unit of standardized design without sacrifice of any worthwhile advantage and with important benefits of economy in both first cost and operating expense?

The answer is a positive YES — providing your capacity requirements fall within the broad range from 10,000 to 300,000 (or more) lb of steam per hr — the capacity range of the VU family (illustrated on the opposite page).

The reason that the VU family can meet — with standardized design — your particular conditions and requirements may be simply stated.

FIRST – let's take load, pressure and temperature conditions. VU Units are in service — many for more than 10 years — operating at a variety of steam pressures up to 1,000 psi and at temperatures to 900 F and above. They are meeting load conditions that vary from the widely fluctuating demands of certain process industries to the above-capacity requirements of overloaded steam plants.

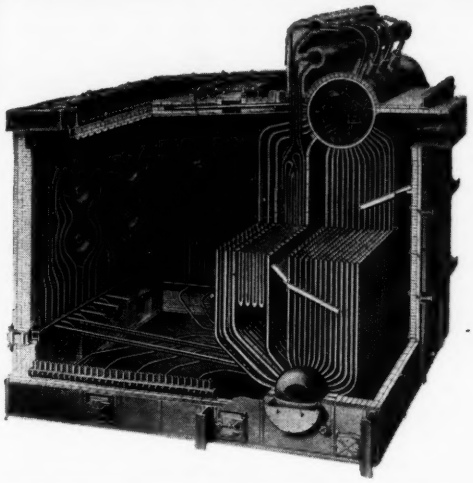
NEXT – let's consider your fuel situation. The VU family is versatile. No matter what fuel — oil, gas or coal, alone or in various combinations — the VU furnace design is adaptable to the most suitable type of firing equipment.

AND FINALLY – let's take a look at physical layout, i.e., space conditions. With the integral, water-cooled furnace in front of the boiler surface instead of below it, head room is seldom a problem. Since width, depth and distance between drum centers are variable in standard increments, virtually any space situation can be met. And you can have deep ash pits or shallow as required, economizer and/or air heater surface if necessary.

Industry—world-wide—has purchased units of the VU family with an aggregate capacity of more than 88,000,000 lb of steam per hr. So you can select a VU Unit with confidence that you will get all the economic benefits of service-proved, standardized design in an installation suited to your particular conditions. B-265-A

COMBUSTION ENGINEERING

A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY

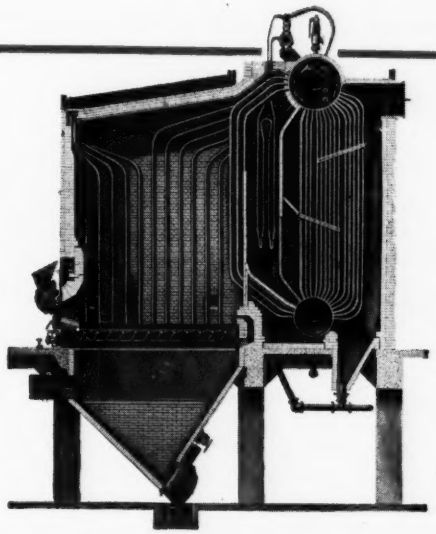


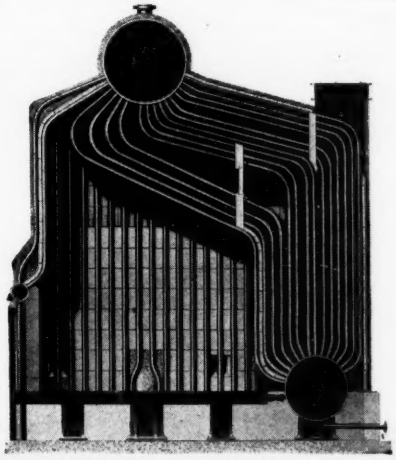
Type VU Steam Generator (for the higher capacity range)

This unit, the original VU design, may be fired by pulverized coal, oil or gas, or any combination of these fuels. Available for capacities up to 300,000, or more, lb of steam per hr, pressures up to 1000 psi and steam temperatures up to 900 F, or higher. Furnace bottom may be as shown or may be of hopper type. Economizer or air heater surface may be added.

Type VU Steam Generator (for the middle capacity range)

In this VU design, shown equipped with a C-E Spreader Stoker, the furnace proportions and arrangement of water wall surfaces may be adapted for firing by any type of mechanical stoker. Design is also adaptable for firing by oil or gas. Economizer or air heater surface may be added. Approximate capacity range 25,000 to 100,000, or more, lb per hr.





C-E Package Boiler (for the lower capacity range)

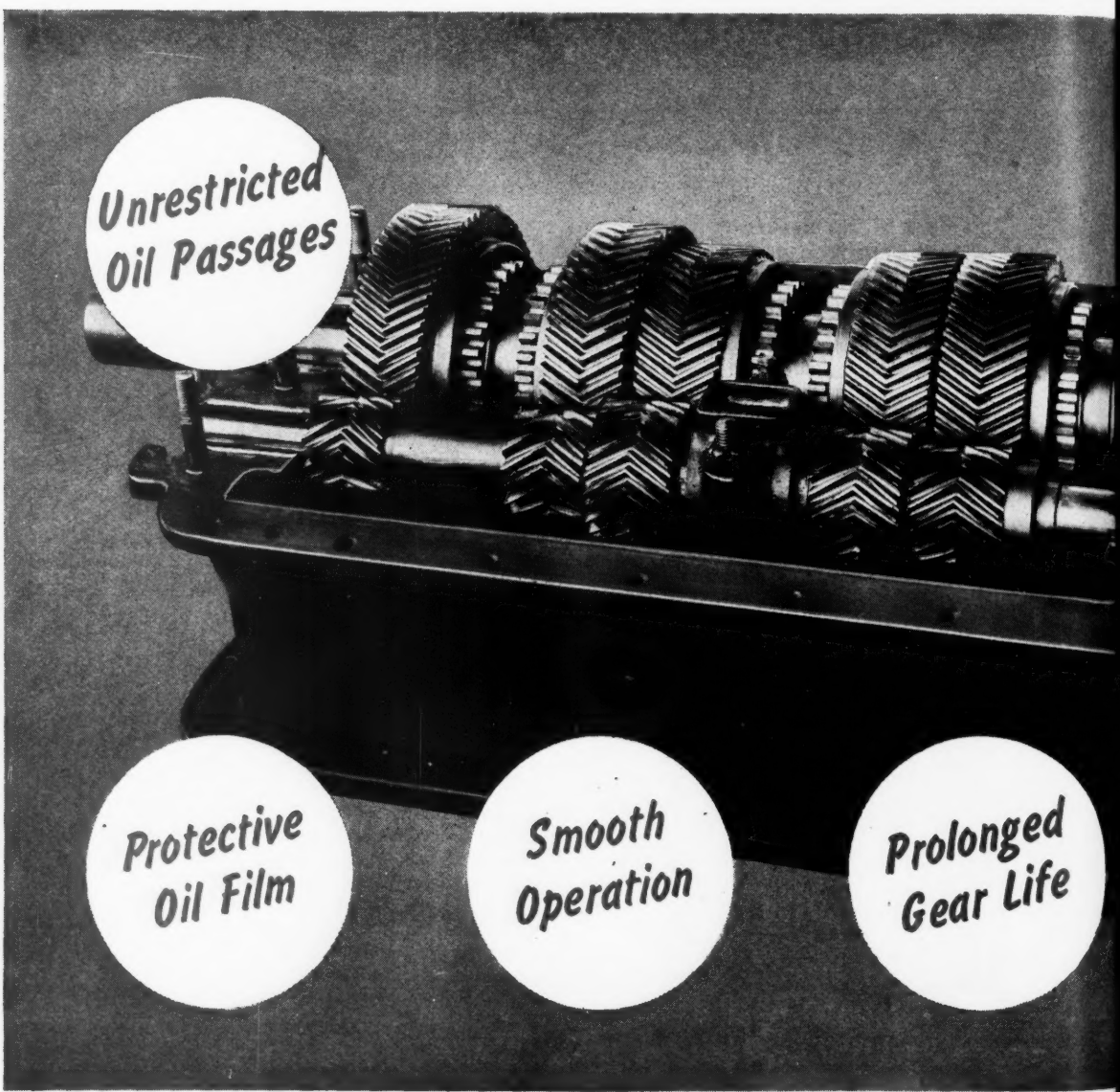
This member of the VU family is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 10,000 to 50,000 lb per hr. Firing may be by spreader stoker, single-retort underfeed stoker, oil or gas burners. Any of these methods may be substituted for any other, should fuel market conditions make this desirable.

C-E — SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

SINCLAIR RUBILENE
To Promote



SINCLAIR

YOUR NEAREST SINCLAIR AGENT WILL GLADLY ARRANGE

Withstands Punishment Gear Efficiency

Inside a Speed Reducer, the lubricating oil is being churned and temperatures run high. This promotes oil oxidation, and formation of acidic compounds, gum and sludge. The result is lower efficiency, accelerated bearing and gear wear—perhaps even complete failure.

With Sinclair RUBILENE as the lubricant, the danger of insufficient lubrication and excessive wear are no longer a worry. Product of the most modern refining processes, RUBILENE resists oxidation, thereby retarding the formation of damaging acidic compounds, gum and sludge. It is non-foaming, too. So, with a constant flow of protective oil to bearings and gears, RUBILENE stands up under the day-in-and-day-out continuous gear operation . . . without frequent need for draining or replacement. Try Sinclair RUBILENE Oils.

This Pilot Plant, part of the great Sinclair Research Laboratory at Harvey, Ill., provides space for six miniature operating replicas of commercial-sized refinery units. Continuous research explains the high quality of RUBILENE and other Sinclair Oils.

Making a study of crystal structure of catalysts, this Sinclair researcher at Harvey uses physical chemistry to develop refinery techniques in a never ending effort to bring industry better petroleum products at lower costs.

INDUSTRIAL OILS

FOR LUBRICATION COUNSEL, OR YOU MAY WRITE TO SINCLAIR REFINING COMPANY, 630 FIFTH AVE., NEW YORK 20, N. Y.

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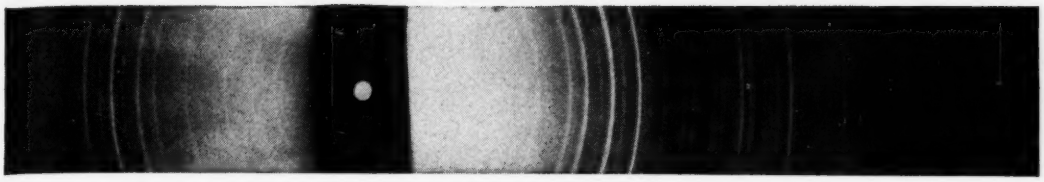
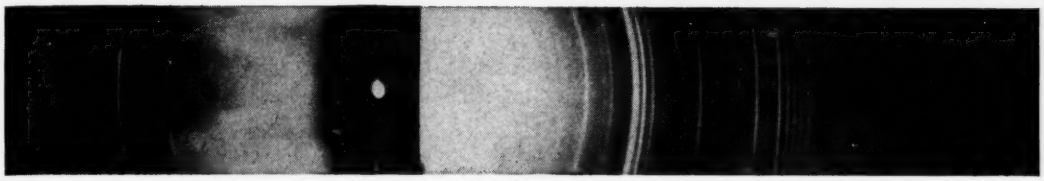
tube troubles





When a deposit causes trouble in a boiler tube, X-ray examination of the material frequently gives information which is not easily obtained by any other means.

In the examination of such deposits, X-rays are directed on a very small sample of finely powdered material. Each crystal diffracts a small portion of the incident X-ray beam, the angles of diffraction depending on the composition and crystal structure of the material. The diffracted beams are recorded on a film, and the pattern which results is an integrated picture of the sample.

Diffraction patterns made by the various compounds found in boiler deposits are as individual as human fingerprints, and provide just as positive identification. A deposit from a boiler tube usually yields a pattern which is a composite of several different compounds. The individual constituents are picked out by comparison with standards, the "fingerprints" of pure compounds.

A typical example of this X-ray "fingerprinting" is the analysis of deposits containing calcium phosphate. There are two forms of calcium phosphate found in boilers. It is frequently desirable to know which is present. Chemical analysis and microscopic examination of the usual sample do not permit ready distinction between them. On the other hand, when samples containing the two forms are ignited, totally different patterns for the calcium phosphate constituent are obtained. The illustration shows this wide difference.

Positive identification of a compound when other methods might give uncertain results is only one of the advantages of X-ray examination—and the X-ray is only one of the full kit of "tools" used by Hall Laboratories in their study of your boiler problems. The thoroughness of Hall methods, employing every technique which might be of value, explains why so many plants of all types and sizes, in all parts of the country, are using Hall service.

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pennsylvania.

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(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

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Cuts Pump Upkeep

COST DOWN MORE THAN HALF IN 4 YEARS SERVICE AT MICH. CITY PLANT

SAYS A. C. LOHSE, General Power Engineer, Pullman-Standard Car Manufacturing Company — "Maintenance costs on our old pump were sky-high, so in March, 1945, we installed this *Electrifugal* pump to move condensate from our compressors and hydraulic pumps. It has run 16 hours a day, five days a week with only routine maintenance and one repacking. Cost per gallon is less than half what it was and performance is much more dependable."

This is the kind of dependable, cost-lowering service you can get from *Electrifugal* pumps. Motor and pump are mounted on *one* shaft in *one solid frame* for maximum rigidity. Feet are wide spread for firm support. Bronze ring protects casing from wear by impeller and is easily replaced when required.

Every *Electrifugal* pump is tested at the factory. Performance is guaranteed.

Allis-Chalmers makes hundreds of pumps for many types of service. For full information, see your A-C Authorized Dealer or District Office, or write for Bulletin 52B6059E. Also in Sweet's. A 2640

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TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

Electrifugal, Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

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WICKES type "S" standard two drum unit

The Wickes Type "S" Standard 2-Drum Unit is designed for industrial plants and particularly where operating and maintenance forces are small. This unit has a generating capacity of 15,000 to 50,000 lbs. steam per hour. It is adaptable to any standard method of firing—oil, gas, single retort underfeed stoker, or spreader stoker, and should the fuel market change, any of the above methods of firing may be readily substituted. With the Type "S" Unit, space conditions are no problem, since the design of the furnace makes this unit a low head boiler. The depth, width and distance between drum centerlines being variable in the standard design, virtually any space situation can be met. Your boiler problems will receive our engineers' consultation and recommendation without obligation.

the WICKES Boiler Co.

SAGINAW, MICHIGAN

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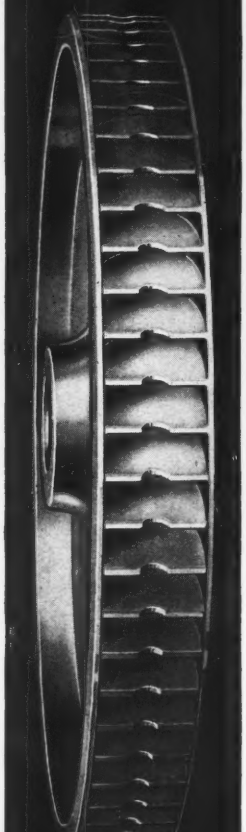
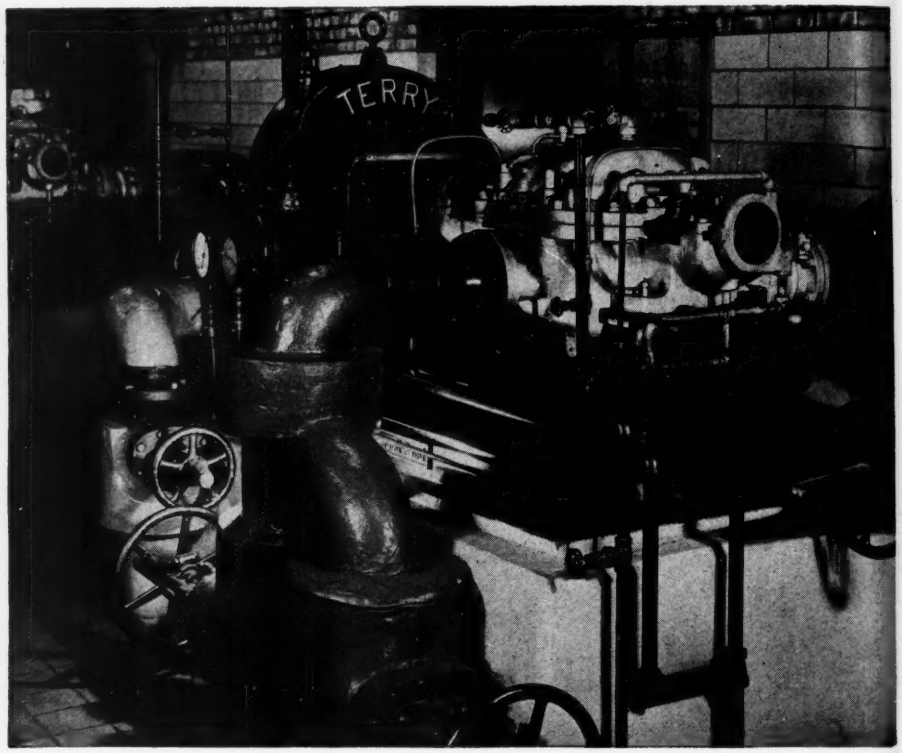
TERRY





110hp Feed Pump Turbine with Large Safe Clearances

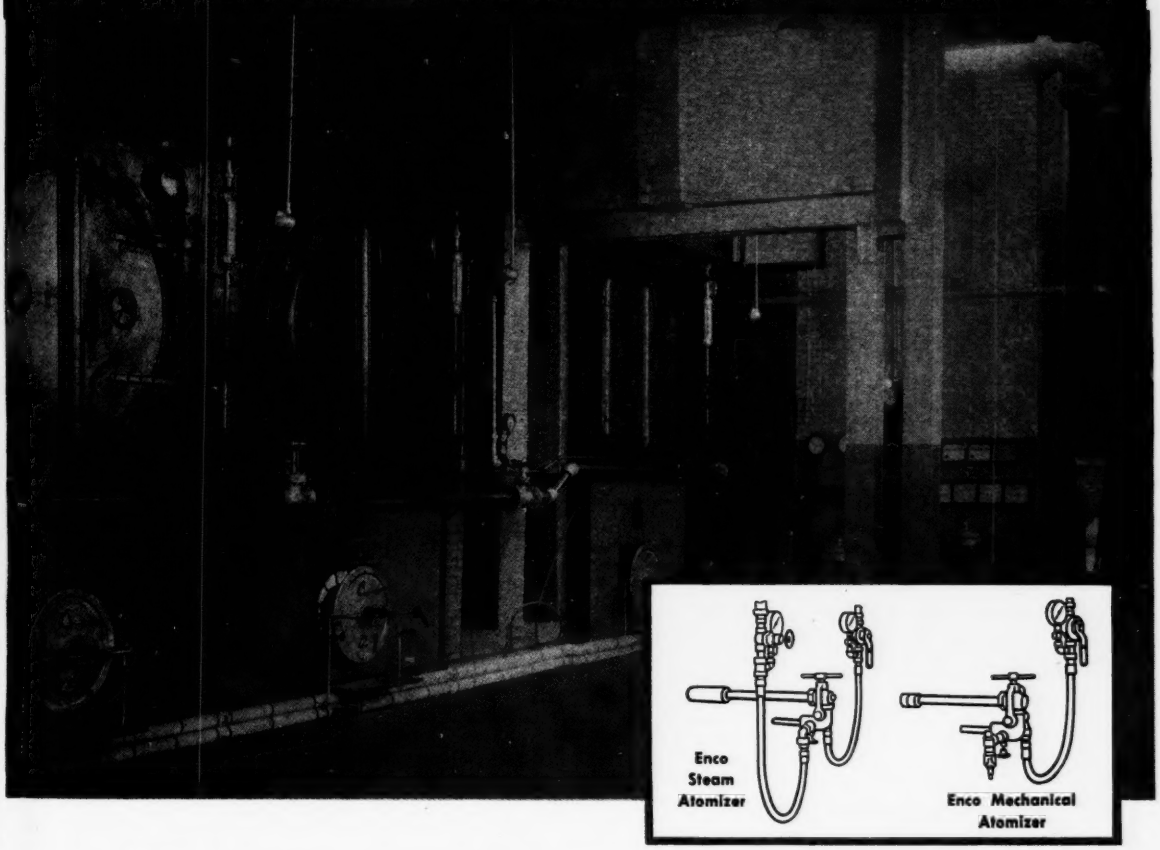
The blades of this turbine are milled out of a one-piece forged-steel wheel with generous clearance both radially and axially. The side clearance is very large — one inch — and the blades are protected by a projecting rim on each side of the wheel. It is therefore impossible for the blades to foul and end play can do no damage to the turbine.

These are but a few of the features that make the Terry Solid-Wheel Turbine such a dependable driver. A bulletin giving other interesting facts about this turbine will be sent upon request.

T 1170

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Swinging Load Demands are Easily Met with ENCO OIL BURNERS



In power plants where steam demands swing from high peaks to low loads over short periods, burner tip changes often become a nuisance to the engineer . . . and a source of man-hour loss which soon shows up in over-all cost figures.

With Enco Wide Range Atomizers, this frequent changing of burner tips is eliminated.

Used with all grades of liquid fuels, Enco Atomizers are designed for instant change of guns for operation with either steam or mechanical system. They are made in various sizes with capacities from 10 to 1,000 gallons per hour.

Enco Atomizers are often used with various types of pulverized coal and gas-burning equipment to provide a dual fuel unit for cold starting, or for full-load operation, when other fuels are unavailable or are less economical than oil.

For 30 years, Enco Burners have been leading the way to more efficient, more economical boiler operation. Write today for further information, or see your local Enco Representative.

EC-471

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Enco Streamline Baffles
Enco Oil and Gas Burning Equipment
Enco Fuel Oil Pumping and Heating Units
Enco Automatic Combustion Control

THE ENGINEER COMPANY

75 West Street, New York 6, N. Y.
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F. J. Raskin Ltd., 370 Rachel E., Montreal, P. Q.

Laboratory illustration of good water treatment . . . and bad. Test rods, in same water, same temperature and circulation conditions, but only one with Nalco treatment added (left), show the improvement you can expect with The Nalco System.
— Nalco Laboratories Photo

Nalco

SERVICES AND PRODUCTS

- A Nalco SURVEY provides a complete water treatment picture, with recommendations if necessary.
- LABORATORY RESEARCH keeps modern chemicals and water treatment methods at work *for you.*
- PRODUCTS recommended by Nalco are designed to deliver full water treating value, in the forms best suited to your plant requirements.
- PLANT SERVICE by thoroughly experienced water treatment engineers... Keeps The Nalco System up-to-the-minute in your plant.
- TEST EQUIPMENT furnished by Nalco makes routine tests and control procedure fast and accurate.
- THE NEW NALCO SR SERIES OF PRODUCTS alleviate fire side deposits.

WHAT IS GOOD WATER TREATMENT?

WE CAN all agree that *good* water treatment should provide clean pipe lines from the raw water intake through all equipment and including condensate return lines. It should provide clean valves, cooling systems, turbines, and boiler and processing equipment free from scale, corrosion, slime and algae. Boilers should be maintained free from foam so that steam can be produced in a satisfactorily dry condition with blowdown kept at a minimum. Such a condition should be maintained on a permanent basis with a *good* system of water treatment.

This, briefly, is the Nalco idea of *good* water treatment. It is the kind of water treatment that is possible and has proven economical in thousands of plants now using The Nalco System.

For your own satisfaction, and at no obligation whatever, ask to have a Nalco field representative survey your plant so that you may decide for yourself the benefits The Nalco System has to offer.

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6224 West 66th Place • Chicago 38, Illinois
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THE *Nalco* SYSTEM • Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Electrical Diagram Guide**—The purpose and use of electrical diagrams supplied with switchgear equipment are explained in Bulletin GET 1293A. It was written to help those who install, operate or maintain switchgear equipment make the best use of the diagrams that come with such equipment. Discusses in detail one-line, elementary, connection and interconnection diagrams. It tells their scope and uses and illustrates symbols used and common variations and explains ASA device function numbers and conventions. Apparatus News Bureau, General Electric Co.

102 **Substation Transformers**—Illustrated Bulletin 61B6014A covers industrial substation transformers. Describes operational and constructional features which contribute to efficiency and service life of these transformers. Photos show typical complete larger and smaller models and construction details. Also included are dimensions and ratings. Allis-Chalmers Mfg. Co.

103 **Distribution Lightning Arresters** — Bulletin GEA 2977B, 12 pp, describes and illustrates lightning arresters for protection of distribution secondary line equipment, watthour meters and other power devices and appliances on secondary services. Discusses major considerations in protection of low voltage a-c power circuits and secondary services, and describes pellet arresters, thyrite protectors and pellet protectors in detail. Includes photos of equipment, dimensional data, ratings, oscillograms showing impulse protective characteristics. Also quotes prices. Apparatus Dept., General Electric Co.

104 **Annunciator Bulletin** — Eight-page Bulletin 120 describes and illustrates supervisory annunciators designed to give visible and audible alarms whenever overheating, low fuel oil or cooling water level or other conditions call for prompt attention. Shows photographs of several models, including lamp type, manual reset type, illuminated stencil type, and special designs and discusses each in detail. Tells type of signals provided, performance, resetting, mounting, construction, wiring, equipment furnished and further equipment required for use. Discusses briefly the role of annunciators in preventing shutdowns of vital services and protecting costly equipment. Auth Electric Co., Inc.

105 **Magnetic Pulley Data**—Bulletin 350, 8 pp, describes permanent magnetic pulleys of Alnico magnet steel. Discusses economy and performance of these magnets, tells how to select them. Gives specifications and dimensions of pulleys and pulley separators and includes graph showing comparative strength of these and other magnets. Photos show some typical installations. Stearns Magnetic Mfg. Co.

106 **Welding Directory**—With 16-pp Bulletin 466 it's easy to choose the correct electrode for hard surfacing applications. It presents a general discussion on arc weld surfacing, explaining how selection of electrode is dependent on service required, service conditions, part to be surfaced and dimensions and finish. Includes tabular guides for selecting electrodes according to specific job requirements and describes each type of electrode individually, telling its applications and properties. Book is illustrated with photos of welding operations and parts reclaimed by means of surface welding. The Lincoln Electric Co.

107 **Electro-Magnetic Control Catalog**—Designated as Condensed Catalog No. 700, it covers in 16 pp most of manufacturer's line of automatic transfer switches, emergency lighting switches, remote control switches, a-c and d-c contactors, a-c and d-c relays, solenoids, close differential and reverse current relays, field discharge switches, electric heater control panels, elevator control devices, and accessories. It's generously illustrated with photos and diagrams and includes ratings and standard features. Automatic Switch Co.

HEATERS, HEATING

108 **Space Heaters**—Bulletin 523, 12 pp, covers forced air space heaters, direct-fired by oil, gas or combination fuel and ranging in output from 400,000 to 2,000,000 Btu, for comfort heating, year-round ventilating, tempering make-up air, process drying and heat curing. It discusses their design and principle of heat distribution and lists 18 reasons why these heaters are recommended for open space heating. Includes specifications, capacity and dimension tables, sketches illustrating operating principles and construction details and photographs showing the heaters in use. Dravo Corp.

109 **Pump and Heater Sets**—This 4-pp illustrated bulletin is devoted to fuel oil pump and heater sets designed to meet specific requirements. Contains schematic drawing showing basic unit and several photographs of complete installations. Describes both "simplex" sets having a single group of component elements and "duplex" sets in which all equipment is in duplicate, so each item could carry the entire load, to eliminate possibility of a shutdown. Peabody Engineering Corp.

110 **Tubular Heaters**—This 24-pp illustrated booklet describes a line of tubular heaters originally designed for heating oil and corrosive fluids in gasoline plants and refineries, but which have also been successfully used for high temperature heating and other applications including those involving severe field operation conditions. Discusses two types of heaters—those with cast return bends and those with welded forged return bends—their construction and applications, and gives specifications. Good-sized, clear photographs of models are used to illustrate this booklet which is designated as Section 3, Part 5 of manufacturer's General Catalog 54. Black, Sivalls & Bryson, Inc.

111 **Lining Bulletin**—A simple means of lining flues, ducts and breechings is described in this 4-pp bulletin. Tells how method can be adapted by user to any duct lining problems. Describes and illustrates insulation, studs and casting and shows how they are applied. One page tells how to estimate necessary material for job and how to order it. M. H. Detrick Co.

112 **Heating Element Data**—Bulletin No. 20, 8 pp, contains detailed capacity and dimension tables on manufacturer's "Paracoil" heating elements. Illustrations and descriptions provide instruction for installation of heating elements and diagrams show six commonly used installation arrangements of hot water generation using these heating elements and storage tanks. Includes conversion table for steam and temperature conditions for determining capacity of any size heating element. Davis Engineering Corp.

TREATMENTS, PREVENTIVES

113 **Protective Coating**—Bulletin 1540, 4 pp, is devoted to a corrosion resistant coating for cold, wet surfaces. Tells its protection against corrosive effects of natural fresh and salt water, cold acid and alkali solutions, acid fumes and atmosphere under shelter. Discusses in detail the use of this coating in water storage tanks and in condensers. Tells how coating should be applied and how to order it. Bulletin also includes photos and description of equipment recommended for use in applying the coating. The Dampney Co. of America.

114 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co.

115 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. This is the 10th in manufacturer's series of engineering bulletins. Allis-Chalmers Mfg. Co.

116 **Metal Maintenance**—Bulletin C-2, 4 pp, titled, "How to Protect and Repair Metal Equipment for Corrosive Service," tells how to mend cracked, broken or corroded metal surfaces of practically all process equipment and how to protect metal against corrosion damage. Explains necessary treatment for specific conditions, tells coating best suited for the job and shows how to prepare surface, mix coating and apply it. Lists acid, alkalis, solvents and salts to which manufacturer's thermosetting resin coatings are resistant and discussees each of these coatings in detail. Carboline Co.

VALVES, TRAPS, PIPING

117 **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical

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POWER GENERATION

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usefulness to those who deal with problems invioved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

118 **Solenoid Valve Catalog** — Solenoid valves for automatic and remote control of the flow of liquids and gases are described and illustrated in Condensed Catalog No. 200-R, 12 pp. It covers manually reset safety shut off and trip valves; electrically operated shut off valves, both packed and packless; pilot valves; explosion-proof valves; special valves, and filters and strainers. All types are illustrated with photos. Sizes are given and applications discussed in detail. Includes photos of typical installations. Last page lists manufacturer's representatives according to cities. Automatic Switch Co.

119 **Steam Trap Catalog**—Thermostatic Steam traps for high pressure industrial service are covered in manufacturer's revised Bulletin 250A, 8 pp. Contains general discussion on these traps, how they're made and how they operate. Includes dimensions, specifications and capacities of traps listed, also prices. Cut-away photos show construction details and sketches show hook-ups. Sarco Co., Inc.

120 **Strainer Bulletin**—The protection of regulators, instruments and traps against dirt, scale and foreign matter by means of strainers is covered in 4-pp Bulletin 712. Describes and illustrates forged steel strainers; tells how they're built, how they work, how they're cleaned and how they can be applied. Dimensions and weights are included. Photos show strainers, parts and a power plant installation in which strainers are used ahead of steam traps. Edward Valves, Inc.

121 **Pipe Unit Bulletin**—Cast-iron insulated pipe units for protection of underground insulated piping are described and illustrated in one-page Form 4810. Tells construction, available sizes and lengths, specifications and industrial applications and advantages of these units. The Ric-Wil Co.

COMPRESSORS, PUMPS

122 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage, and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

123 **Air Compressor Lubrication Manual** —Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

124 **Motor-Pump Data**—The design, construction and performance of combination motor-pump units are discussed in Bulletin MP-101, 6 pp. Includes cutaway illustration of unit and photos of complete assembly, a 2-pp performance table and dimensions. The Frederick Iron & Steel Co.

BELT DRIVES

125 **Leather Belting Manual**—"How to Select, Install, Maintain Modern Leather Belting," is the title of this well organized and clearly written 28-pp guide to maximum belt performance. It explains how leather belting can save money and space and increase production; tells how to select and order belting for various drives and applications and includes handy formulas for finding belt speed, length, arc of contact etc. A chapter on installation discusses aligning, tension, running direction, quarter turns; it illustrates tools needed for the work and includes step-by-step directions for handling single- and double-ply belting. Chapter on maintenance tells how to care for belts, clean and dress them and shorten them. American Leather Belting Association.

126 **Compressor Drive Handbook** — The short center leather belt drive, its operation and advantages for driving compressors, fans and pumps are described and illustrated in this 16-pp handbook. It discusses basic requirements of efficient drives and shows how these are suited for the work. Includes a chapter on the importance of belt tension; many illustrations. Pictures of installations show belt drive in red against black-and-white of rest of photo for clarity. J. E. Rhoads & Sons.

MISCELLANEOUS

127 **Refrigeration Condenser Catalog** — Designated as Bulletin RC-1, this 24-pp illustrated catalog covers ammonia and freon refrigeration condensers of horizontal and vertical construction. Includes specifications, dimensions and applications according to type. Lists weight and prices of available models and includes property tables for refrigerants and safe external working pressures for steel tubes. Sketches and line drawings show construction details and arrangement of units; photos show many installations. Henry Vogt Machine Co.

128 **Silicone Bulletin**—A pictorial introduction to the complexities of Silicone manufacture is provided in 12-pp Bulletin CDC. It includes brief descriptions of the outstanding characteristics and principal uses of manufacturer's Silicone resins, oils, greases, rubber, and water repellents, and summarizes the steps by which these five classes of products are made. Chemical Dept., General Electric Co.

129 **Data and Conversion Tables**—Now available are the latest editions of five tables helpful to anyone dealing with steel tubing. Included are the following cards: No. 115, "Tolerances of Round Seamless Steel Mechanical Tubing," giving permissible variations in diameter and wall thickness for cold-drawn unannealed and finish-annealed and for hot-finished tubing; No. 112, "Metric Conversion Table," a handy reference which converts millimeters to decimals of an inch; No. 110, "Linear Conversion Table," giving the relation of inches and fractions of inches to decimal parts of a foot; No. 103, "Wall Thickness Data for Seamless and Welded Tubing," showing wire and sheet metal gage equivalents, in inches and millimeters; and No. 125, "Hardness Conversion Tables," giving approximate relation between hardness by Rockwell, Vickers, Shore and Brinell testing systems, and tensile strength of carbon and alloy steel. The Babcock & Wilcox Tube Co.

130 **Gage Bulletin**—Latest developments in manufacturer's line of multi-pointer gages are described in Bulletin No. 163-B, 8 pp. Use of the diaphragm operated unit for measurement of pressure, drafy or differential is explained in detail and some of available standard ranges are listed. Describes in detail 4 styles of casings available in sizes to accommodate up to 12 units. Also discusses use of gases to indicate high pressures and temperatures. Data includes net and shipping weights and complete dimensions of casings. Illustrations include photographs of gages, diagrammatic and cut-away drawings. Bailey Meter Co.

131 **Industrial Insulation Catalog**—Mineral insulations for practically every purpose are covered in this 20-pp illustrated catalog. It describes in detail insulating cements for both high and low temperatures, high temperature block insulation, block finishes, felts, blanket insulation, pipe coverings, loose wool, weatherproofing and stack paints. Includes information on what each class of insulation is for, what it can be expected to do, how it's applied, how it's packaged and, in most cases, how much it costs. Discusses requirements of a good insulation and tells how these products meet the requirements. Forty-Eight Insulations, Inc.

132 **Hydraulic Seal Analysis**—This is an 8-pp letter-size illustrated reprint of an article in Machine Design for Dec. 1948. Gives a clear-cut analysis of advantages and disadvantages of various types of "sliding type" hydraulic seals now in use. Discusses recently developed "leakproof seals," explains cause of chatter, and covers general operating characteristics of metallic and non-metallic piston and piston rod seals and gives recommendations for their application. Miller Motor Co.

133 **Thermocouple Manual**—Described as a "buyer's guide and user's manual," Bulletin P1238 (55 pp) covers thermocouples and pyrometer accessories. First part contains a general discussion of thermocouples, their construction, function, specific applications and suggested methods of installation and location. Buyer's guide section lists available equipment, specifications and sizes. A third section is devoted to thermocouple calibration data. Included with this book is an 8-pp price list. Illustrations include photos and sketches of models, dimensional drawings, installation layouts, mounting diagrams. Two "plus" features are an illustrated table of contents and definitions of technical terminology used. Both catalog and price sheets are punched for filing in binder. The Bristol Co.

134 **Wire Rope Slings**—Details of design, advantages and applications of flat laced wire rope slings are furnished in 12-pp Bulletin No. FLS-49. It's illustrated with photos showing these slings handling heavy machinery, a Diesel truck, refinery tower, transformer etc. Photos also show different types of hooks and loops. Drawings illustrate details of rope sections and lacing. Technical data includes dimensions and weights, safe loads of slings and fittings, and dimensional drawings. A. Leschen & Sons Rope Co.

135 **Diesel Bulletin**—Diesel engines for stationary and marine service, for duafuel or oil burning operation, supercharged or non-supercharged are covered in illustrated Bulletin 163, 8-pp. It describes in detail a vertical 4-cycle, single-acting, trunk piston type engine of 16½ in. bore and 24½ in. stroke, rated from 815 to 1900 hp at speeds of 277 and 300 rpm. Photos show several views of this and other engines and illustrate construction and parts. Dimensions and ratings included. Nordberg Manufacturing Co.

136 **Precipitator Bulletin**—Six-pp Bulletin DL-P-1513 stresses the over-all economy of an electronic air cleaner in eliminating smoke, dust, smudge, bacteria and pollen. Illustrates and describes precipitator models with and without blower. Gives dimensions and specifications, and illustrates operating principles. Photos show typical installations. Raytheon Manufacturing Co.

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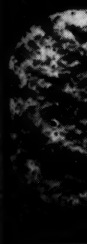

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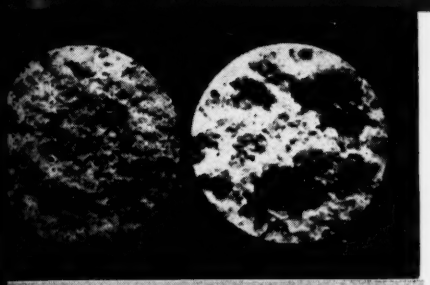
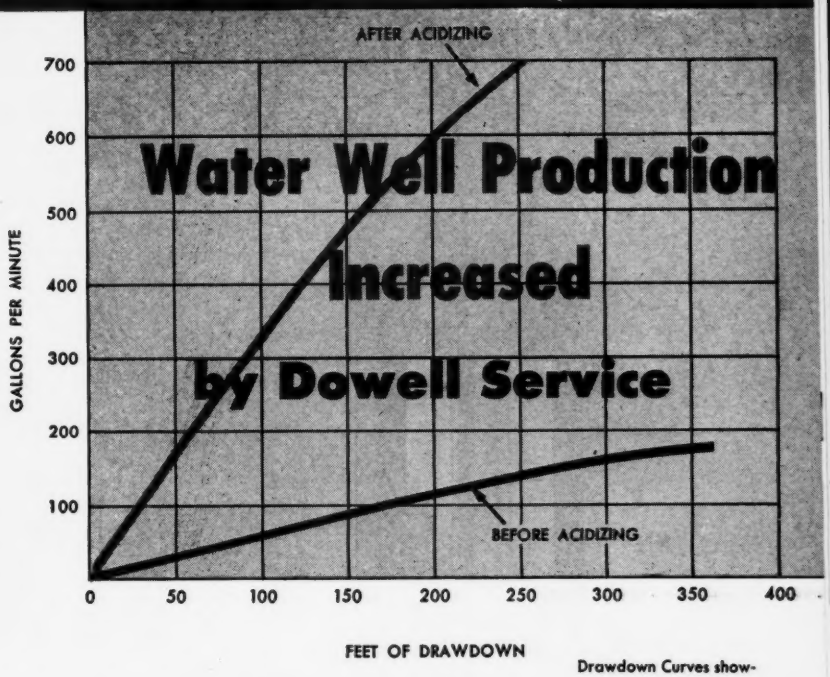
DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS



Acidizing of the limestone core above produced the enlarged passages shown in the right hand photograph.

The photographs below, taken with a subsurface camera, show the screen in a gravel-packed well before and after acidizing.



Drawdown Curves showing the advantages which have been obtained from proper chemical treating of water wells.

Scale incrustations and corrosion products on the well screen, pump, tubing and face of the producing formation will cut down the output of your water well. Dowell Acidizing Service is designed to remove these water-stealing deposits easily and quickly. Also, production may be increased due to enlargement of the water passages in the formation itself.

Case histories of many Dowell serviced wells show excellent results. For example, in a 1900 foot deep water well, calcium carbonate and iron oxide incrustations on the slotted liner had cut production to 65 g.p.m. After Dowell service, the well produced 632 g.p.m.—*an 872% increase.*

Dowell Acidizing Service requires a minimum amount of mechanical work since pulling of the pump or the screen is usually unnecessary. Experienced Dowell engineers do the entire treatment—using mobile equipment, they bring the proper solvents to the well site along with all necessary pumps, mixers and control equipment. Your nearest Dowell office will be glad to give you complete information and free cost estimates.

CALL

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

New York 20	Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.
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Philadelphia 2	Pittsburgh 19	Oklahoma City 2	Charleston 27, W. Va.
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Richmond 19	St. Louis 8	Ft. Worth 2	Midland, Texas
Jacksonville	Indianapolis	Shreveport 23	Wichita Falls, Texas
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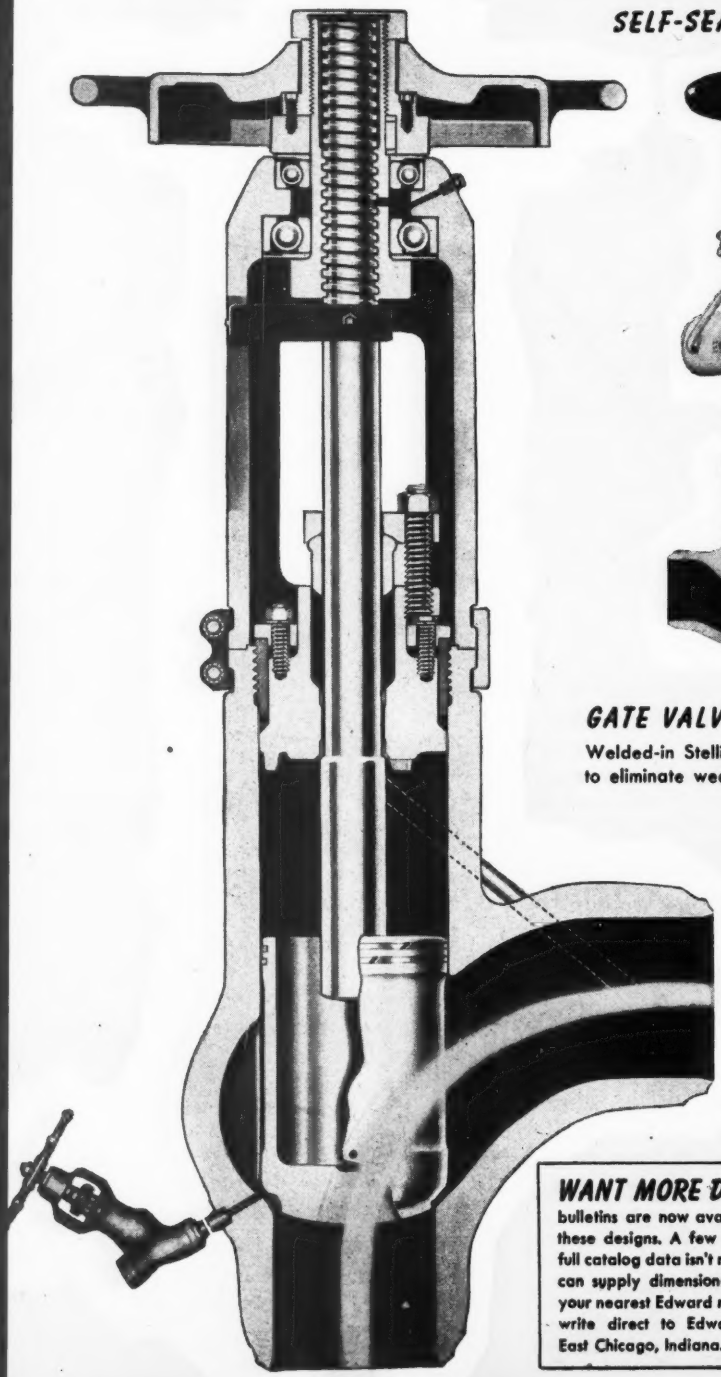
Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

SERVICE ORGANIZATION

They're New!

NEW PRESSURE SEAL BONNET VALVES.. NEW FORGED STEEL GLOBE VALVES.. NEW IMPACTOR HANDWHEELS..NEW G

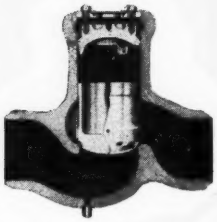


SELF-SEALING BONNET JOINTS, 30% MORE FLOW

Now you can get Edward pressure-seal bonnet valves in gate, globe or angle patterns for stop, check or non-return service. New features for lower and lower pressure drop have been built in—and **proved.** On no other valve series is there more proven flow data.

EDWARD PATENTED EVALTHRUST YOKE BUSHING

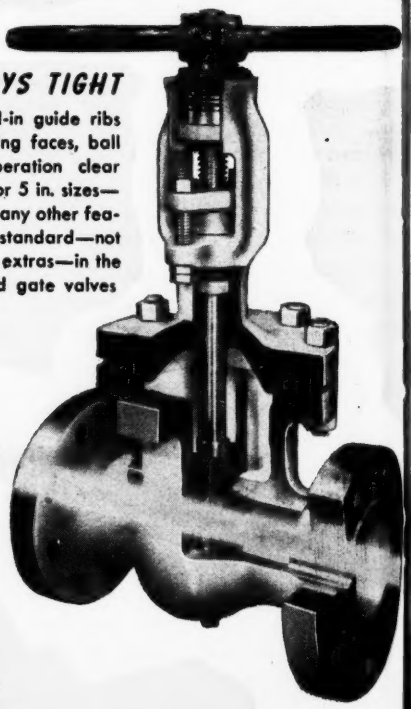
and Impactor handwheel for easiest closing in cramped locations is standard on stop and non-return series. So is closure indicator.



ON CHECK VALVE, left, and non-return valve, far left, note new enclosed dash-pot disk, Edward Equalizer for high disk lift and free flow passage. The whole series is regularly built in chrome-moly steels for stability at high temperatures.

GATE VALVE THAT STAYS TIGHT

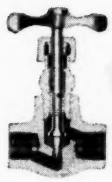
Welded-in Stellited seats, welded-in guide ribs to eliminate wedge drag on seating faces, ball bearing operation clear down to 4 or 5 in. sizes—these and many other features are standard—not added cost extras—in the new Edward gate valves



WANT MORE DATA? Special bulletins are now available on most of these designs. A few are so new that full catalog data isn't ready yet, but we can supply dimensional drawings. Ask your nearest Edward representative, or write direct to Edward Valves, Inc., East Chicago, Indiana.

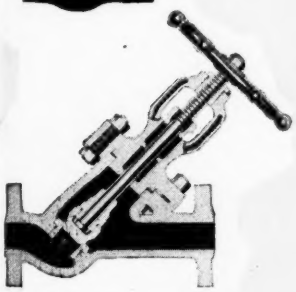
A WHOLE NEW GROUP of Edward Steel Valve Designs

NEW GAGE VALVES.. NEW WELDED BONNET UNIVALVES.. NEW BLOW-OFF VALVES... NEW GATE VALVES



FINE REGULATION ON GAGE LINES For gage and meter service, the redesigned Edward Fig. 152 valve gives close flow regulation with small seat port and longer seat-stem contact area. New form fitting T-Handle. Rated 4000 lb W.O.G. Also in 12% Cr. and 18-8 stainless steels.

ALL-PURPOSE SMALL GLOBE VALVE Here's a new O. & Y., union bonnet, bolted gland forged steel globe valve for a multitude of services. Packing adjustment or replacement greatly simplified. Rated 800 lb, 750 F.



BLOW-OFF FLEXIBILITY A new series of 300 lb O. S. & Y. blow-off valves with all the design features of high pressure valves. Install them in any position for greatest piping flexibility.

Boiler blow-down installation, 1500 lb 1000 F with new Edward welded-bonnet straightway blow-off valves. Compact, tight, easy to open and close with new Impactor handwheel.

NEW, EASIER CLOSING Now the Edward Impactor handwheel, modernized and improved, is available on many small valves as well as large. Easy-to-grip cross bar delivers 2.8 times the closing load of ordinary handwheels. No wrenches or extension bars needed.

NEW WELDED-BONNET UNIVALVE
Already lowest in pressure drop among forged steel globe valves, Edward patented welded bonnet Univalves have been modified to give even less resistance to flow, less wear-producing turbulence. For top temperature service and up to 2500 lb pressure, here is the valve that offers the most.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO. EAST CHICAGO, INDIANA

Specify Republic

A Republic combustion control system operates the three boilers in this new power plant which supplies all the steam and power for a large university. During the first year of operation this new plant provided heat for 13.0 percent more building space, generated 114.3 percent more electric power but consumed 9.86 percent less fuel.

REPUBLIC
INSTRUMENTS
AND CONTROLS

Combustion Control

TO INCREASE TODAY'S STEAM PRODUCTION

TO DECREASE TOMORROW'S STEAM COST

The installation of Republic automatic controls on your boiler (or boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hr. a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions and thereby prevent the chain-of-event type of trouble that frequently developes as a result of incorrect boiler operation.

An automatic combustion control system, as designed and built by Republic, will help you meet today's need for more steam and tomorrow's need for lower steam costs.

The Republic combustion control is a unified system controlling simultaneously, in measured quantities and in correct proportions, the fuel and air input to the boiler. It increases or decreases the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency. It not only checks operation but automatically makes necessary corrections of individual factors before faulty operation has a chance to develop.

The difference between such a control and an assembly of uncoordinated regulating devices is comparatively small in equipment but great in principle. Merely to provide automatic operation of a number of individual device is not enough.

CHECK THESE FEATURES

Built into the Republic combustion control systems are many features that enable it to fulfill all the conditions of theoretically perfect combustion control and still meet all the demands of everyday operation.

Check the following features against your list of "musts" for a perfect combustion control system.

CENTRALIZED CONTROL: The operation and control of the boiler or boilers is centralized at the master controller.

FUEL-AIR RATIO INDICATOR: The master controller is provided with mercury manometers which indicate the measured fuel and air inputs to the boiler and the fuel-air ratio.

FUEL-AIR RATIO ADJUSTMENT: A handwheel on the front of the master control panel provides a convenient means for adjusting the fuel-air ratio.

ALL BOILER RATINGS: Maintains proper fuel-air ratio over the entire range of boiler ratings.

CONSTANT STEAM PRESSURE: Maintains the plant steam pressure within narrow limits of variation by proportioning the fuel and air inputs to the load.

LOAD DISTRIBUTION: Provides a means of distributing the load among the boilers as desired.

MANUAL CONTROL: Boiler ratings can be controlled manually by a handwheel located on the front of the panel.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time. Write us today.

Republic Flow Meters Co.

2240 Diversey Parkway • Chicago 47, Illinois

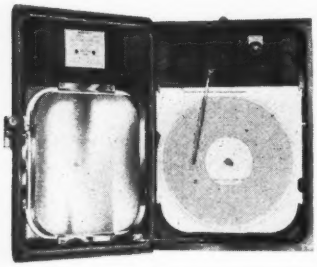
NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

1—RECORDING INSTRUMENT

Plots on circular chart a curve of operations against time

A new instrument, the Running-Count Recorder, records total count of intermittent operations and the time each one occurs, and is used on production machinery to record work-producing operations or number of pieces produced. With this recorder, the total number of operations or pieces produced can be found by multiplying the

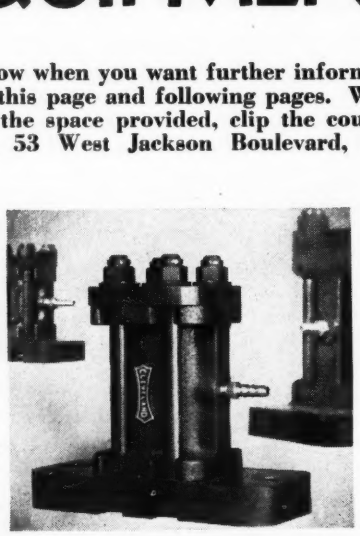


number of complete pen tranverses across the chart by the count per tranverse for which the instrument is calibrated. Hourly rate of production can also be read from chart. This gives information regarding effect of fatigue on operators, variations in productibility between operators, effectiveness of job training programs, and effect of variations in working conditions. Excessive down time is easily read. The instrument may also be used as basis for paying production employees. The Bristol Co.

2—SHAKE-OUT VIBRATORS

For installation on almost all hoppers and storage bins

Type "F" pneumatically-operated vibrators deliver hammer-like blows to prevent arching-over and plugging of



sand, coal, grain, ore, lime slag and chips in bins having capacities ranging from one to several-hundred tons. New sizes have been added to this line of vibrators, and all are claimed to assure constant and rapid flow of materials and eliminate manual pounding. They are suitable for intermittent or continuous duty. Vibration is developed by oscillation of a hard-chrome-plated heat-treated solid steel piston which travels length of a cast semi-steel cylinder body under air pressure. Vertical construction permits operation in any position.

Available in 6 sizes with piston diameters from 1¼ to 4 in. overall widths from 3 to 7½ in. and lengths from 6 to 15 in. Extra large and heavy-duty models furnished on request. Speeds of operation range from 2100 vibrations per minute on smallest model to 750 vibrations per minute on largest model, when used on standard line pressure of 80 psi. Speeds vary with line pressure maintained. When used with manufacturer's type "JN" lever-type valve, vibrators operate only when the hopper discharge gate is in 'open' position. Type "F" vibrators range from 9.5 to 185 lb in weight. Cleveland Vibrator Co.

3—"DIESEL" GUMOUT

Is a new additive for Diesel fuel and heating oils

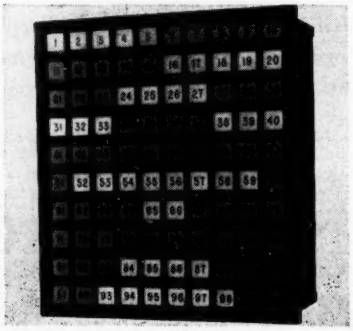
For use in Diesel engines, "Diesel" Gumout is intended to dissolve gum and sludge in cleaning the fuel lines and injection system, thus keeping them clean. It is designed to maintain a continuous, free flow of fuel to the engine, to give more power and economy as well as higher combustion efficiency, and to prevent freezing of any moisture which may be present in the fuel. The manufacturer recommends adding one pint of "Diesel" Gumout to the tank (for every 50 to 100 gal of fuel) once each month. It is packaged in 5-gal pails; 15, 30 and 55-gal drums as well as one pint cans. Pennsylvania Refining Co.

4—ANNUNCIATOR

Is now available with windows designed for distance reading

Formerly designed with "windows" of 1x1 in. engraved Lamacoid giving the effect of white or red letters on a black background, the type "ANG" annunciator is now available with either black Lamacoid or white, translucent plastic windows. Annunciator operates on 24, 48, and 125 v ac or dc.

When a normally open supervisory or "trouble" contact closes in a thermal unit to indicate high bearing temperature, for example, this action causes control relay of the appropriate annunciator designation to close. This closing illuminates lamp and sounds an audible alarm which continues until signal is acknowledged by pressing a common silencing switch mounted separately from the annunciator. Operation of switch for one acknowledgement, however, does not prevent the functioning of the audible alarm in the event of subsequent "trouble" contact closures. Illumination of lamp behind designation continues until extinguished by pressing a common reset switch which functions only when "trouble" contacts have returned to their normally open position. Circuiting is arranged so that a common test switch may be used to test all lamps simultaneously. The Autocall Co.



APRIL, 1949

POWER GENERATION

53 W. Jackson Blvd.
Chicago, Ill.

Please have the manufacturers send me without obligation information or bulletins indicated by the following item numbers.

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Complete Piping Materials Service
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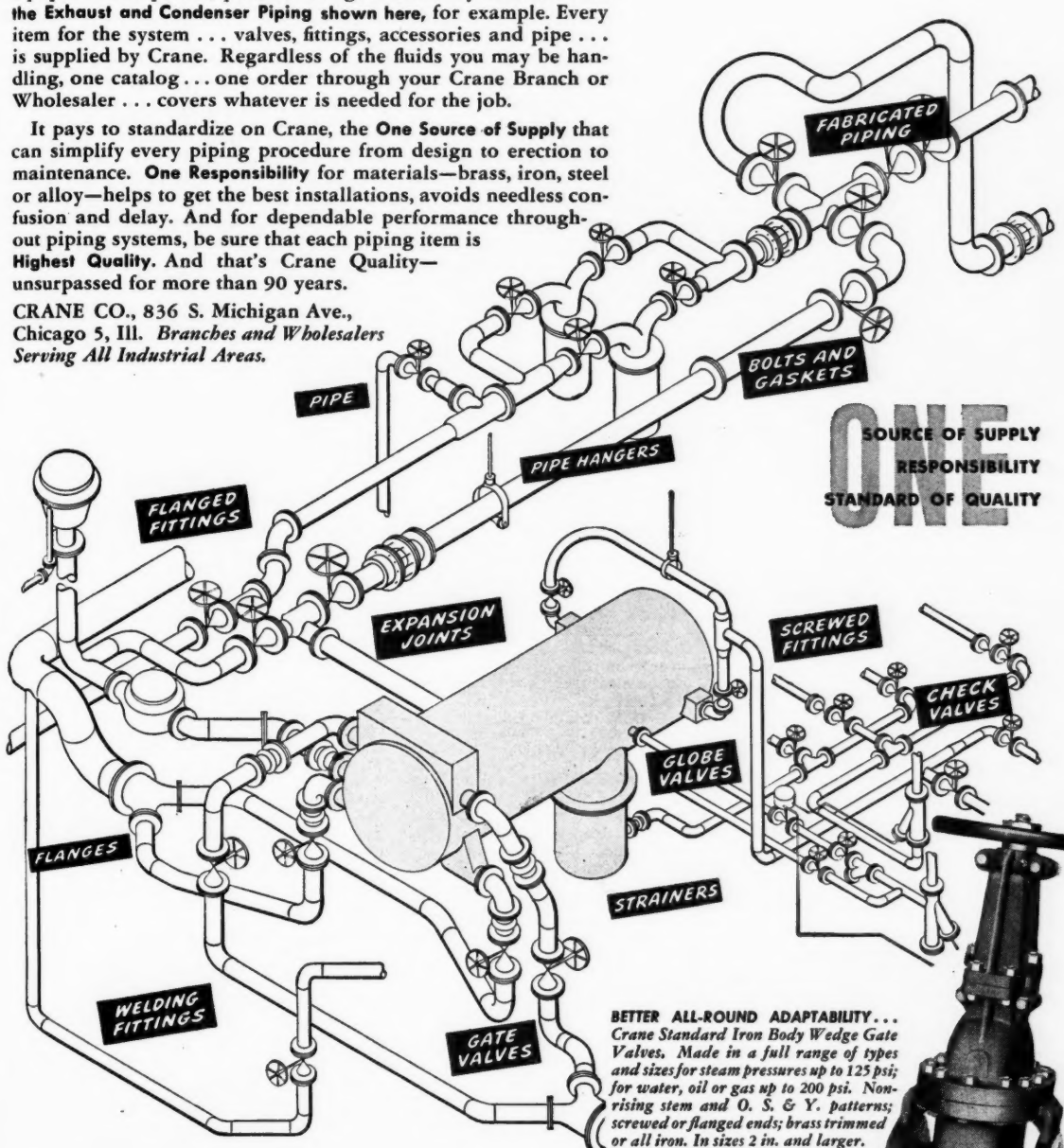
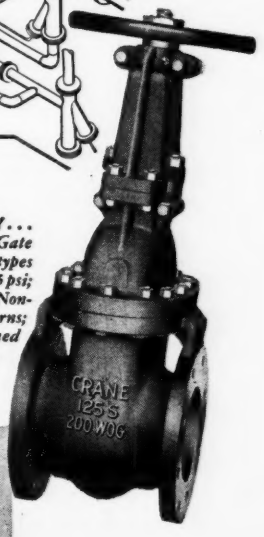
That's the Crane line—the world's most complete source of piping equipment for power, process and general utility services. **Take the Exhaust and Condenser Piping shown here,** for example. Every item for the system . . . valves, fittings, accessories and pipe . . . is supplied by Crane. Regardless of the fluids you may be handling, one catalog . . . one order through your Crane Branch or Wholesaler . . . covers whatever is needed for the job.

It pays to standardize on Crane, the **One Source of Supply** that can simplify every piping procedure from design to erection to maintenance. **One Responsibility** for materials—brass, iron, steel or alloy—helps to get the best installations, avoids needless confusion and delay. And for dependable performance throughout piping systems, be sure that each piping item is **Highest Quality.** And that's Crane Quality—unsurpassed for more than 90 years.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*



BETTER ALL-ROUND ADAPTABILITY... *Crane Standard Iron Body Wedge Gate Valves. Made in a full range of types and sizes for steam pressures up to 125 psi; for water, oil or gas up to 200 psi. Non-rising stem and O. S. & Y. patterns; screwed or flanged ends; brass trimmed or all iron. In sizes 2 in. and larger. See your Crane Catalog, p. 101-6.*



EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

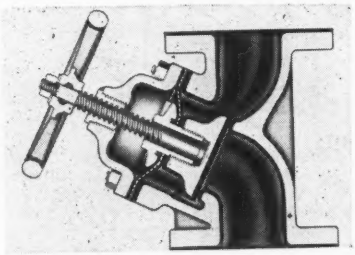
FOR EVERY PIPING SYSTEM

5—DIAPHRAGM VALVES

With separate seating member to give positive control

In this line of diaphragm valves a separate seating member is used to give positive control of flow independently of the diaphragm, reduces the flexing to which the diaphragm is subjected and eliminates the diaphragm crushing action. Shut-off of flow is claimed to be positive at all times.

Plain iron valves come in sizes ½ to 2 in., with screwed ends; and in sizes



½ to 4 in., with flanged ends. Neoprene-lined-and-coated valves are made with flanged ends only, in sizes ½ through 4 in. In the unlined valves, a newly designed flat-face disc with neoprene insert has been used to assure tight seating. In the neoprene-lined-and-coated valves, the entire disc surface is heavily faced with neoprene, which makes a seal with the neoprene-covered seat when valve is closed. These valves have rising-stem construction, sizes 2 in. and under having stem rising through the handwheel and the larger sizes having the handwheel attached to the stem and rising with it. A "packless" type valves, the diaphragm valve seals operating parts from line fluid.

The plain iron valves are for services not exceeding 150 psi and 180 F. Temperature limitations on neoprene-lined-and-coated valves are dependent upon service conditions and fluids carried. Crane Co.

6—HEAVY DUTY CUTOUT

For fusing transformer banks, sectionalizing heavy feeders

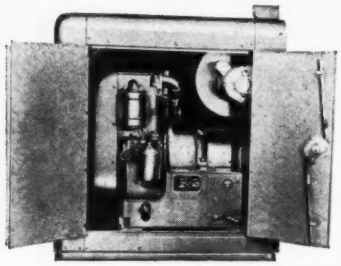
A new indicating unit, rated at 200 amp, has been designed to provide an 8,000 amp full-range interrupting rating at 2.5 kv, (or line-to-neutral on 4160 or 4330-v Grd Y, 4-wire system) complementary to the original interrupting rating 5,000 amp at 5 kv, (or line-to-

neutral on 8330-v Grd Y, 4-wire system). Housing is wet-process porcelain, glazed inside and out; door is molded Textolite compound. A spring-operated indicator arm pulls cable downward and completely out of fuseholder tube for quick interruption even at low currents. This cutout, which has swivel mounting, can be converted to a 400-amp disconnect cutout simply by changing door. The unique disconnect door can be closed with hinged blade in open and isolated position to give positive indication that the circuit is open. Transformer and Allied Products Div., General Electric Co.

7—ELECTRIC PLANT

Diesel powered, packaged; for stand-by service

This new 2500 w, air-cooled Diesel-powered electric plant is housed in sheet steel, the inner surfaces of which have a ⅜ in. layer of sound-proofing and fireproofing material. Plant and equipment are built to be easily accessible for inspection and servicing. Fresh air intake is in top housing panel. Has 15 gal mounted fuel tank with external fuel-fill pipe and connected fuel lines, two heavy-duty 6 v starting batteries. Thermostatically controlled ⅓ hp electric motor driven blower exhausts hot air to maintain proper temperature inside housing. Complete installation weighs approximately 1000 lb.



Powered by manufacturer's DSP full Diesel engine. Electric cranking of engine is by automatic compression release. Generator regulates voltage without rheostats or other external equipment. Economical; requires about 0.136 gal of fuel per kilowatt hour at full rated load. D. W. Onan & Sons, Inc.

8—SMALL STEAM TRAP

For small drainage and light condensate load jobs

Steam trap No. 118 was developed to provide a small trap at lower first cost, suitable for unit heaters, pipe coils, sterilizers, and laundry equipment. May be installed either as an elbow or straight-in-line without extra fittings as only one pipe nipple is required. A blow-down plug and test plug is provided to permit easy cleaning and testing. For pressures up to 150 lb, has a capacity rating of 700 lb per hour (continuous flow) at 20 lb pressure. In ½ in. pipe connection size.

No. 118 has standard construction for manufacturer's line of steam traps. An inverted bucket type, it has castings of nickel semisteel, bucket and guide tube of copper and bronze, and all working parts of heat-treated stainless steel. The simplified design is intended to reduce both installation time and number of fittings. Trap may be inspected without removal, and any or all parts renewed in 3 min, it is claimed. Equipped with thermal air eliminators at slight extra cost. The V. D. Anderson Co.

9—DUCT LINER

Provides means of securing insulation to steel shell

In announcing a new product called Insuliner, manufacturer says this construction can be applied in the field without outside engineering assistance. It is said to provide a definite means of securing insulation to the steel shell to protect surface of insulation, and to stop maintenance because it is all properly supported. This construction is described as block insulation supported by a system of bars held in position by bolts welded to the steel shell. The insulation is then covered with an Insuliner cement to protect it and resist a reasonable amount of abrasion. M. H. Detrick Co.

10—PHOTOELECTRIC UNIT

To safeguard industrial oil burners against flame failure

Fireye System FF-3, designed to afford protection for semi-automatic and manually ignited oil burners, includes a

photoelectric scanner and control. Scanner consists of phototube and vacuum tube amplifier housed in dust-tight aluminum case, mounted on burner mounting plate for clear view of oil flame. If flame fails, control operates to cut off fuel supply and sound an alarm. The control consists of 2 relays and power transformer house in steel case on burner control panel. Includes safety start circuit intended to keep burner from cycling if flame is detected or simulated prior to ignition.

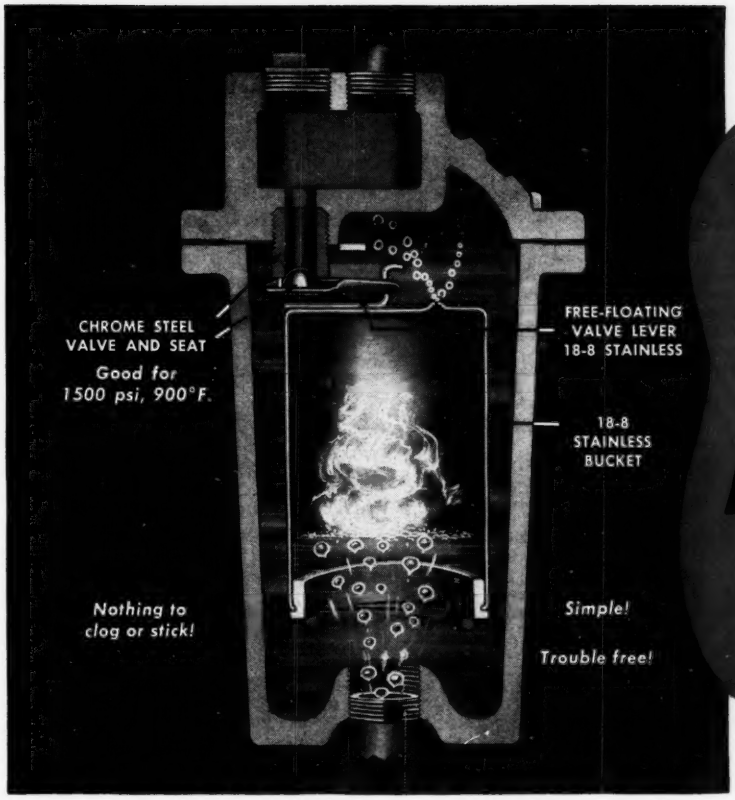
Power relays have readily accessible power contacts. Flame relay is sealed. Failure of vacuum tube or phototube causes instantaneous safety lockout of burner. Electrical interlock prevents starting of burner if flame relay sticks closed. Supply voltage may be 115-230 v; frequency, 60 cycles; power consumption 20 va (10 w); load rating, power contacts - single - pole, single-throw 1 hp plus 125 va pilot duty at 115 or 230 vac; ambient temperature, 32 — 125 F. Auxiliary controls operate from 2-wire thermostat or pressure switch and manual start push-button. Combustion Control Corp.

11—POWER SUPPLY UNIT

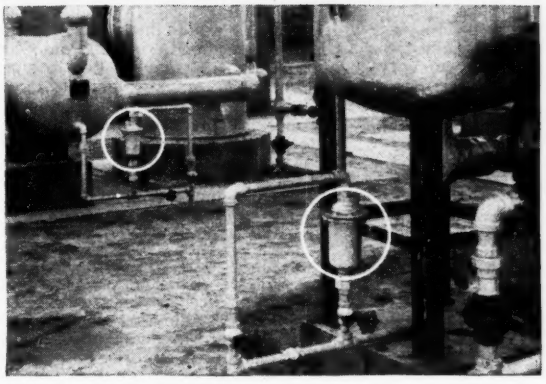
Is flexible source of testing power for 12 and 24 v d-c motors

Designated as PEC 272, this portable rectifier supply unit is caster-mounted and operates directly from the line at usual line voltages. For laboratory or production testing, it may be moved from place to place for uninterrupted service wherever a dependable source of power is required. It is said to maintain d-c voltages at ± 1v of pre-set value and hold a-c rms (root mean square) ripple under 0.15 v. To withstand starting in-rush of current required by d-c motors, solenoids and other control apparatus, the unit has conservatively rated selenium rectifiers capable of delivering 50 amp continuously and up to 200 amp during periods of momentary overload. No warm-up period is required.

Has heavy-duty selector switch for controlling operation from high range of 22-30 v to low range of 11-15 v.



it isn't the cost or the upkeep with ARMSTRONG STEAM TRAPS



IF the first cost of Armstrong Steam Traps was high, which it isn't, they would still be a good buy because of low upkeep.* Maintenance on Armstrong Steam Traps is exceptionally low because:

1. Even in Armstrong Steam Traps for low and medium pressures, the valve and seat are chrome steel, hardened, ground and lapped to leak-tight fit —identical in materials and workmanship to those used in Armstrong traps for pressures to 1500 psi, 900°F.

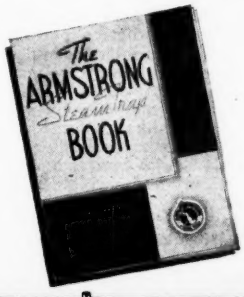
2. The Armstrong free-floating valve lever mechanism is unusually resistant to wear because there is no friction and it is of heavy corrosion-resistant stainless construction.

3. Dirt is washed through the trap by the swirling action of the condensate—and out through the nice big valve orifice.

4. There is nothing to clog, stick, bind or collapse.

Add up these features and you arrive at a trap that very seldom needs maintenance—a trap that saves man hours and money—a trap that pleases everybody from the purchasing agent to the pipe fitter.

THE 36-page ARMSTRONG STEAM TRAP BOOK tells all about these traps, how to select and install them for long, trouble-free performance. Send for your copy.



*You get more hot condensate capacity with Armstrong Steam Traps per dollar of investment than with any others.

P.S. Because they don't leak steam, Armstrong Traps are excellent for saving fuel.

Send for the Steam Trap Book!

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Michigan

ARMSTRONG Inverted Bucket STEAM TRAPS

Factory Representatives in 48 Key Cities... Traps Stocked at 147 Points

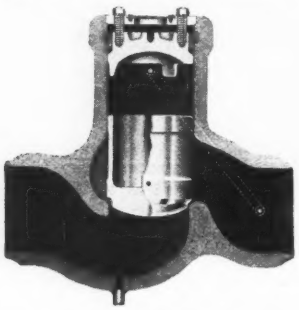
Potentiometer permits close adjustment within each range. Equipment is convection cooled. Designed to operate

in ambient temperatures not exceeding 40 C and under normal atmospheric conditions, according to manufacturer. Power Equipment Co.

12—CAST STEEL VALVES

Have new body design to reduce size and weight

With this new body design it is claimed possible to economize by installing a size smaller valve in pipe lines. Stop and non-return valves in either globe or angle design use the new body for all sizes 6 in. and above in 900, 1500, and 2500 lb classes. Available with pressure-seal or bolted bonnet and with flanged or welding ends. Pressure loss

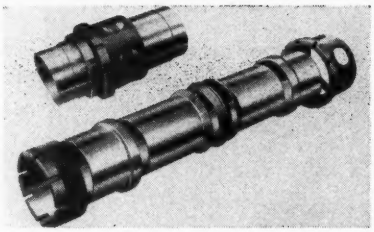


in new design is decreased by streamlined internal contours which eliminate wear-producing turbulence, by reduction of weight in all floating parts, and by equalization of pressures in all internal areas of the valve. Integral seat, composed of Stellite laid directly on valve body, greatly reduces weight by permitting a much smaller body bore. Also, weight is reduced by elimination of unnecessarily thick parts making an even distribution of metal in the body walls. This smooths out the external lines of the body causing the valve to occupy less space. Pressure-seal design is said to effect a great space saving. Edward Valves, Inc.

13—TUBE UNIONS

Lightweight, single-thread type, for joining flared unions

The new "1900" series of tube unions is designed to meet the need for faster, lighter weight connections in fluid lines where heavy fittings and close line spacing create weight problems and high maintenance costs. It's used with flared tube ends and consists of 5 parts: a metal seal ring, 2 sleeves, threaded clamp ring and mating coupling nut



with visual inspection ports. Fast assembly is achieved by single threaded connection designed for use with standard commercial spanner wrenches. Available in 1½, 2, 2½, 3 and 4 in. sizes, in steel or aluminum alloy material. Roylyn, Inc.

14—INDICATING VOLTMETER

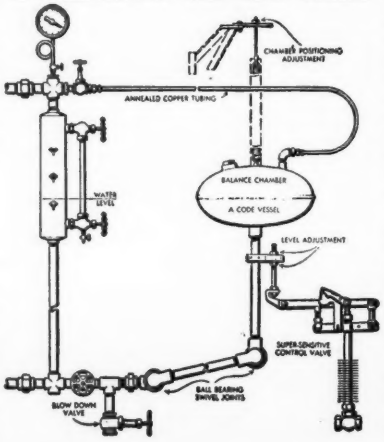
Has expanding scale for detecting, measuring variations

An addition to manufacturer's Type AB-15 line, this voltmeter is designed for general switchboard use by electric utilities and large industries; it has a scale 7.1 in. long spanning 250 deg about the center. The scale is expanded over the most frequently used range, from 90 to 130 v for easy detection and measurement of 0.5-v variations within that range. Accuracy has been determined to within ±½ per cent in the range of 105 to 125 v and ±1 per cent over the entire expanded range. Although available in only one rating, 0-90 to 130 v, it can be supplied with scales applicable to potential transformers for voltages higher than rated. Housed in a dustproof, liquid-resistant case whose over-all dimensions are 4¼x4¼x6⅜ in., it has spring-mounted jewel pivots, anti-parallax scale, high overload characteristics, non-glare glass, shielding from stray fields, and stable performance under conditions of varying ambient temperatures. The normal scale has a white background with black markings; black scale with white markings can be furnished. Meter and Instrument Div., General Electric Co.

15—FEED WATER CONTROL

Uses weight of water to motivate feedwater control valve

Heat and cold are said to have no effect on the "Weight-O-Water" control, because no heat is required to operate it. This controller uses an ellipsoidal balance chamber, a code vessel hung on a spring, to permit its rising and lowering. At top of chamber an annealed copper tubing is connected and flexibly looped to commensurate with water column



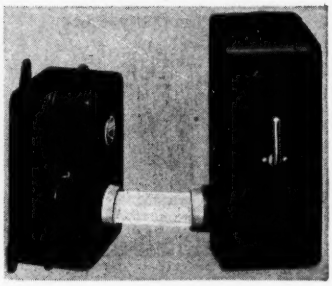
piping of boiler. Chamber is connected to bottom of water column with piping.

Up-and-down movement of chamber actuates a super-sensitive control valve requiring a force of less than ½ lb to actuate. Valve opening and closing in response to this movement controls amount of water fed to boiler. Extreme sensitivity is claimed by elimination of stuffing gland and substitution of an 8 in. Neoprene stem seal. Fins on bonnet extension of valve dissipate heat and prolong seal life. J. A. Campbell Co.

16—SMOKE INDICATOR

Photoelectric, designed for use in average size power plant

Smoke indicator, Type A20C-1, shows density of smoke pasing through flue or breeching of a heating or power plant and signals when density approaches values prescribed by municipal ordinance. According to manufacturer, it is sturdy, reliable, easily installed and low in cost. Consists of photoelectric control and light source mounted on



opposite sides of flue. Light source beam is projected across flue onto control. Equipment may be set to signal at prescribed smoke value. Supplementary equipment available includes bell alarms for excessive smoke, densimeters for continuous indications, and recorders. Designed for usual 115-v and 230-v 60-cycle (or 50-cycle) electric power supply. Weighs 6½ lb. Photoswitch, Inc.

17—SAFETY TRANSFORMER

Protects against shock by reducing 110 v circuit to 6 v

This new portable transformer safeguards workers in damp or wet locations from the possibility of fatal electric shock while working with the conventional type of 110 v extension trouble-lamp. Called Saf-T-Lite, the new device is described as a portable step-down transformer designed to prevent death by electrocution by the accidental grounding of portable extension trouble-lamps commonly used by men working in boilers, tanks, underground vaults or any damp surroundings. The unit weighs only 4¼ lb and reduces a 110 v circuit to only 6 v, a voltage said to be harmless.

Small in size, Saf-T-Lite looks like a large black capsule, the transformer being protected by a strong, waterproof bakelite casing. When connected to an outlet, the unit can be left on floor or table or hung from wall fixture. Also in production is a larger model designed to reduce a 220 v lighting circuit down to 32 v. Contained in an impact-resistant steel casing, this larger portable unit is intended for use in working areas where increased wattage for general lighting is desired. Both the

Keeping stainless steel STAINLESS

. . . a typical problem in fabricating alloy piping

Heat a piece of stainless steel pipe to bend it and right away you're up to your ears in metallurgical complications. To begin with, stainless steel isn't just one alloy. There are hundreds of different types of stainless steel, each selected for its resistance to corrosion or its stability at high temperatures. To maintain the metallurgical properties which dictate the choice of a particular alloy steel, you have to know the temperature range within which this steel may suffer excessive metallurgical changes. And you have to have specialized equipment to maintain the precise control necessary to avoid these hazards.

Grinnell pipe fabrication equipment includes specially designed gas-fired radiant heat furnaces for this precisely controlled heat treatment of stainless steels and other alloy steels. Multiple burners are strategically located to distribute temperature uniformly and to prevent harmful flame impingement. Precision instruments regulate temperature and time.

It's an intricate business . . . fabricating alloy steel piping. It's a job for Grinnell prefabricating plants because Grinnell has the equipment and modern methods, the interpretive engineering, the metallurgical research facilities and the skilled personnel.

GRINNELL

Grinnell Company, Inc., Providence 1, Rhode Island. Branches: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston
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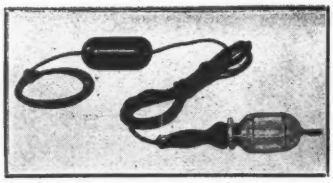


6 v and 32 v models are available with trouble-lamp and 25-ft heavy insulated extension cord, or just as safety transformers with insulated leads. Etraco Mfg. Co., Inc.

18—POLYPHASE METER

Is designed for light industrial and commercial loads

A new Type CAH polyphase watthour and thermal demand meter in a case no larger than the standard 3-element watthour meter is applicable wherever it is desired to incorporate a demand feature within the rate. It is built to reduce space requirements and instal-

lation costs attendant with installation of two separate meters. It's said to have the long life operation and minimum of maintenance advantages inherent in thermal meters. This new line of meters is available for 3-phase, 3-wire; 3-phase, 4-wire delta; open wye network; and 3-phase, 4 wye operation in the usual ratings of 5, 15 and 50 amp at application voltages of 120, 240 and 440. In standardized A-base design. Westinghouse Electric Corp.

19—VOLTMETER

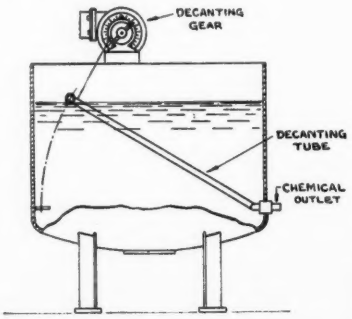
Vacuum tube type, for measuring low-energy circuits

The Type AA-1 vacuum-tube voltmeter measures voltage in electronic and other low-energy circuits where minimum current drain is desirable. This highly sensitive new instrument has a calibrated range of 0.001 v to 300 v at all frequencies from 10 cycles to 1.5 megacycles, and is graduated in decibels, covering range of -52 to plus 52 decibels from reference level of 1 milliwatt at 600 ohms. Ten-position push-button switch permits any working range to be selected instantly without passing through intermediate ranges. For portable or bench use, voltmeter is housed in aluminum case with sloping front panel which supports the indicating instrument at convenient reading angle. Terminals for wires or standard banana jacks are provided for connection to the measured circuit; another set of standard banana jacks is furnished for taking off amplifier output. A 6-ft, two-wire rubber insulated cord, with molded rubber plugs, is provided for connecting the 115-v supply circuit to protected receptable at rear of instrument chassis. Meter and Instrument Div., General Electric Co.

20—DECANTING GEAR

For automatically lowering swing pipe in water softener tanks

This new decanting gear automatically lowers swing-pipe decanting tube in chemical softening tank to the softener in proportion to raw water flow. Its operation is paced by the raw water

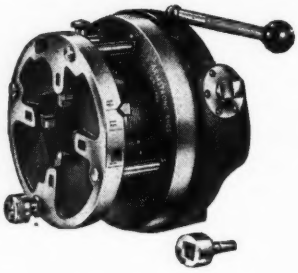


meter. Dial indicates amount of chemical liquid in tank. Connections are provided for attachment of an electric low-level alarm. Tube is positioned by flexible cable attached to shaped and grooved drum. Rotation of drum pays off cable and lowers decanting tube. Drum is driven through oil immersed gears by a 1/40 hp synchronous motor within housing. Motor operates on 110 v, 3 phase, 60-cycle current; 50 or 25-cycle design can be furnished. Water Softener Section, Worthington Pump and Machinery Corp.

21—PIPE THREADER

Is portable, adaptable for use in close quarters

The new No. 165 portable pipe threader is a self-contained, semi-automatic, power-driven thread-cutting machine. Compact and lightweight, it is designed to operate with full speed and efficiency close to walls, in corners, under limited head room and in narrow trenches. It

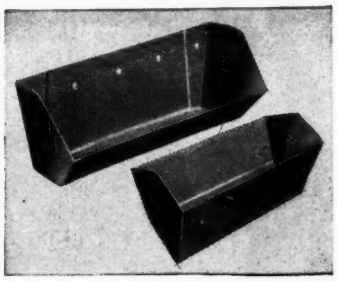


operates easily and is said to give trouble-free service because moving parts run on anti-friction bearings (head on roller bearings, drive and back gears on ball bearings). Cuts smooth, close-fitting threads on 1, 1¼, 1½ and 2 in. pipe all with one set of steel chasers. Sturdy drive adapter fits any standard ½ in. three jaw drill chuck. Weighs only 26 lb. Complete with set of chasers and drive adapters it costs $121.50 net. Armstrong Bros. Tool Co.

22—ELEVATOR BUCKET

High speed type, it handles free-flowing materials

The design of this bucket is said to combine high capacity, durability, low operating cost and exceptional strength with light weight. Recommended for

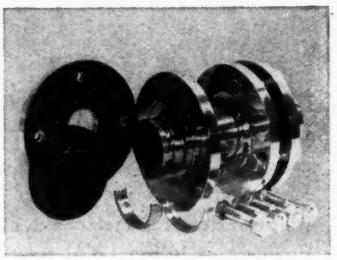


handling grain, soft feeds and other fluffy, granular or powdered free-flowing materials which are not excessively abrasive. These buckets may be mounted on belt at intervals or continuously, depending on capacities required. Have spot welded construction, tapered ends for maximum pickup and for nesting in storage and shipping, smooth interiors, uniform strength throughout, holes located for correct balance. Can be installed to replace old buckets on existing elevators. Link Belt Co.

23—PIPE JOINT

Is easily and quickly installed in rubber lined pipe

Here's a device, called the Gaco Joint, which is claimed to cut insulation and repair costs by as much as 50 per cent. Lined pipe may be bought in sections which can be installed right on the job in a few minutes, requiring no detailed



layout plans or welded fittings. By keeping a supply of these joints in stock repairs can be made by plant maintenance crews, thus avoiding lengthy shutdowns. Gaco Joints come in 1½ to 4-in. pipe sizes as 45 and 90 deg ells, Y's, tees and separate flange kits for connecting straight lengths. Pipe is cut, grooved, bored or counterbored with special machine or regular pipe machine with adapter. Kit for adapting user's own machine is available, or special machine may be bought or leased. Gates Engineering Co.

24—LIGHTING PROTECTOR

For meters, power service entrances, consumer apparatus

Rated at 0-650 v, this new Thyrite unit is available for indoor or outdoor installation on single or poly-phase secondary circuits. Single, double, or triple-pole assemblies are enclosed in compact

SANTOBRITE effective, low-cost SLIME AND ALGAE CONTROL

To eliminate sluggishness and obstructions caused by slime and algae in cooling systems, use Santobrite*— Monsanto's Sodium Pentachlorophenate, Technical. An inexpensive, effective algaecide, Santobrite is recommended for use wherever water is not used for drinking or bathing.

The Santobrite treatment requires no special equipment of any kind . . . Merely add to circulating water at any convenient location. Results are equally satisfactory whether used in large industrial installations or smaller systems.

To learn how Santobrite can help you maintain peak efficiency in cooling operations, send for a copy of Monsanto Technical Bulletin O-15. Address MONSANTO CHEMICAL COMPANY, Desk B, Organic Chemicals Division, 1765 South Second Street, St. Louis 4, Missouri.

SANTOSITE

controls oxygen corrosion in boiler systems

By removing all traces of residual oxygen, Santosite* (Monsanto's Sodium Sulfite, Technical) prevents oxygen corrosion in boiler tubes and other steam generating equipment. For complete information on this simple, economical control, send for a copy of Monsanto Technical Bulletin O-26. *Reg. U. S. Pat. Off.

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CHEMICALS — PLASTICS

MONSANTO CHEMICAL COMPANY
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Please send me ( ) Technical Bulletin O-15, on Santobrite; ( ) Technical Bulletin O-26 on Santosite.

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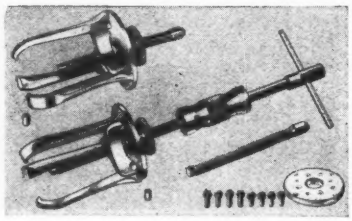
SERVING INDUSTRY . . . WHICH SERVES MANKIND

cylindrical aluminum cases, with provision for either nipple mounting through the knockout holes of meters, or connection boxes, or bracket mounting to building or pole. Flamenol line and ground leads extend 18 in. outside threaded nipple. Weatherproof covering is colored for easy identification—black for the line leads and white for the ground lead (common to all poles). Flamenol insulation is claimed flameproof, chemically inert for resisting chemical action and weathering, and free from sunlight checking. Allied Products Div., General Electric Co.

25—THREE-JAW PULLER

Safe, uniform power for removing pulleys and gears

This puller can be used by any mechanic. Spring tension holds jaws on work, and locking nut makes it possible to lock the puller on the job so it will not come off until released. This allows operator to use both hands for actual pulling operation. This is said to assure slipless, tipless pulling of all jobs within jaw capacity. Jaws are forged and heat treated. Maximum jaw capacity on outside holds is 8½ in, and the jaws are reversible to operate through a 2½ in.



opening for inside pulls on bearings and sleeves. Yoke is forged with two sets of jaw slots allowing the jaws to be moved closer to the center for better gripping power on small jobs.

Available as either a screw type or combination screw and booster hammer type. As a screw type it can be operated with any ¾ in. wrench and screw automatically centers on all "turned" shafts. For shafts without centering holes a special screw point protector is provided. A circular plate attachment is available to adapt puller for use on water pump and generator pulleys, tapped fiber gears. Unit attaches to the gear or pulley close to hub by cap screws, and puller is attached in usual manner. Snap-on Tools Corp.

26—HAND TORCH

Is small and easily handled, also economical to use

The new I.C.C. approved Torchmaster is a general utility, self-contained hand torch only 2¼ by 13 in. burning liquid petroleum gas. Holds enough fuel for an average day's burning. The torch will do light brazing, soldering, and innumerable heating operations. It burns upside down or at any angle and has a filtered "Wind-Pruf" burner that will not clog or blow out, according to manufacturer. Of steel construction, satin-chrome finished. A single control valve turns torch on and off and adjusts the flame from a pencil point to a roaring blowtorch. Can be filled from standard containers for from 3 to 5 cents. The Torchmaster costs $19.50 without filling adapter; deluxe version, with adapter and baked enamel finish, is $22.50. Industrial Engineered Products Co.

27—LIGHTWEIGHT HOIST

Is strongly constructed for heavy-duty work

Outstanding feature of Auto-Bloc hoist is its hoisting mechanism, which employs only 2 gears and affords weight savings. These are a cam-actuated floating inner gear and an outer gear to which the load sheave is connected. Gears of special alloy steel provide

maximum strength with a large number of teeth in mesh at all times. The Auto-Bloc cover, claimed unbreakable, is drop-forged from chrome manganese steel with a tensile strength of 200,000 psi. Every working part is of high quality heat-treated steel. No lightweight materials are employed. Available in 16 standard models of ½ to 40 t capacity. Every hoist is factory tested for 50 per cent overload. David Round & Son.

28—HEADREST GOGGLES

Are lightweight and comfortable and easily adjusted

These are said to be more comfortable than other goggles because headrest distributes weight over the entire head. Easy to raise and lower, the goggle assembly is hinged from sides of headrest by telescopic arms. Concealed springs hold goggles against face. Federal specification lenses are standard 50 m size, available in shades 2 through 6 and held in individual eye cups of molded plastic joined together flexibly for easy fitting. Outside of each cup has ventilating screen and baffle plate to keep out flying particles and stray light rays. Headrest is light, clean plastic, easily adjusted to any headsize. Sweatband adds to comfort. Price $5.50, includes lenses. General Scientific Equipment Co.

29—IMPACT SOCKETS

Can be used on pneumatic and impact wrenches

Recent additions to manufacturer's "Supersocket" line bring the number of styles and sizes to over 150. They are adaptable to all socket locking methods used on power and impact wrenches. It is claimed their accurate fit and precision machining assure long, dependable service. Made of heat-treated, extra tough alloy steel, they come in 7 square drive sizes with hex openings

from $\frac{3}{16}$ to 3½ in. and 8-point openings from $\frac{7}{16}$ to 1¼ in. in regular and bolt clearance lengths. J. H. Williams & Co.

30—FIRE RETARDANT PAINT

Called Flame-Seal, this new paint is easy to handle, ready to use, requires no special ingredients, and can be applied directly from original container by brush or spray-gun. Manufacturer reports that tests show Flame-Seal generates no smoke or toxic gases when attacked by fire and gives off no toxic fumes while being applied. It is claimed that unpainted lumber protected with a coating of Flame-Seal can withstand a 2000 F blow-torch for 30 min without any flame spread.

When fire attacks wood coated with Flame-Seal, says manufacturer, the paint forms a "magic" white crust which creates a hard protective wall at least 8 times thickness of original coating. The new fire-retardant paint is also said to be moisture-proof and termite-proof, and will not craze, chip, peel or crack. Can be washed with any standard soap or washing powder. Available in an oyster-white flat finish in single quarts, 2 and 5 gal cans and 55-gal drums. Stallton Chemical Corp.

31—STRAP SELECTOR

For determining the proper anti-corrosion strapping

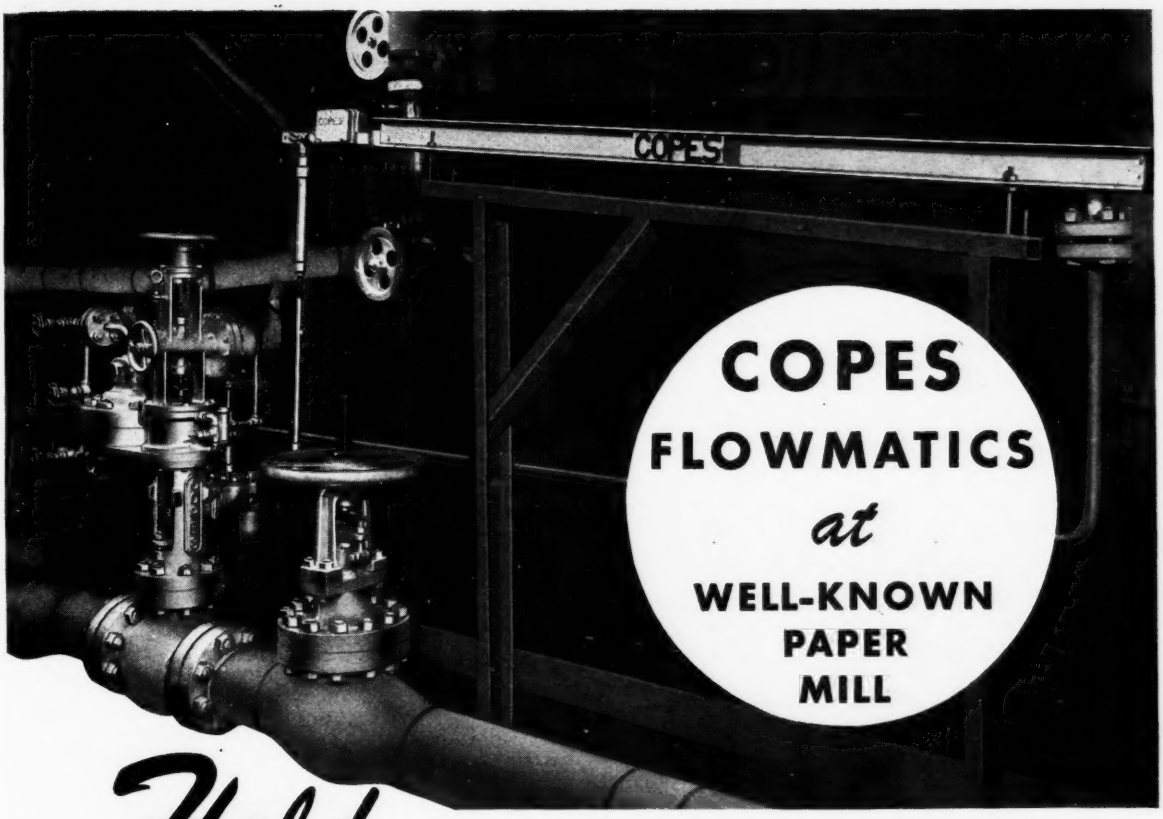
In operating this handy device, the user simply dials an arrow so that the arrowhead points to the type of chemical condition, atmospheric environment, soil, water or gas fumes to which the strapping will be exposed. An opening in the butt section of the arrow then automatically reveals which metals will, and which will not, give good service under the specified condition. Practically every type of service condition is covered. It's a simple matter to pick the right strap from the 7 different varieties of metals in which Steelbinder strapping is available. Opposite side of selector is a handy calculator for determining with slide rule precision the length and weight of steel or aluminum strapping required for any given binding operation. You may have the Strap Selector-Calculator without charge. Ask for it. A. J. Gerrard & Co.

32—SPEED CONTROL DRIVE

For small lathes, grinders, pumps and other equipment

Now available from stock is this Thymo-trol drive, Type H1, furnished in ratings through ½ hp. It utilizes a simplified half-wave circuit to provide d-c flexibility from a-c power. Designed to provide smooth, stepless speed control on small lathes, grinders, drill presses, conveyors, pumps and mixers.

Operates from 220v, 60 cycle a-c. Has a 20-to-1 speed range from 1725 to 86 rpm and operates in ambient temperatures from 50 to 104 F. In non-reversing or reversing types, latter has separate magnetic reversing switch. Designed for constant torque loads under normal conditions this drive provides speed regulation from no load to full load. Speed may be preset or varied during operation. Dynamic braking permits quick stopping. Maximum tube life is obtained when voltage fluctuates no more than 5 per cent. Electric panel is mounted in compact vestibule enclose. Easily wired, terminals are at front of panel and separated from tubes. Inexpensive, prices begin at $168. General Electric Co.



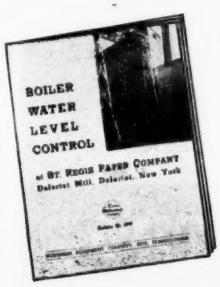
Hold CLOSE WATER LEVEL on fast-steaming boilers taking rapid swings

Here is one of two COPES Flowmatics serving 810-psi, 825-F C-E Type VU boilers in one of New York State's most modern paper mills. Rated at 110,000 pounds per hour, each boiler is subject to a sharp load change every three minutes. Despite this severe service, drum water level is held within plus-or-minus one inch.

NORTHERN EQUIPMENT COMPANY

492 Grove Drive, Erie, Pennsylvania

BRANCH PLANTS in Canada, England, France, Austria, Italy • *Representatives Everywhere*



The story of this important installation is told in Performance Report Bulletin 479. Write—on your letterhead, please—for your copy.

COPES

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Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

★ Tops FOR TOP PRESSURES

On steam lines where pressures go as high as 1500 psi, and temperatures up to 900° F. are encountered, steam traps must be rugged . . . and *efficient!*

That's why so many public utilities and other high pressure steam plants are installing Yarway Integral Strainer Impulse Steam Traps. First cousin to the famous standard Yarway Impulse Steam Trap, the integral strainer trap has been developed especially to meet high pressure trapping requirements.

It has ample condensate capacity when system is being "warmed up." Yet it will handle relatively small amounts of condensate efficiently without losing prime. The valve closes positively in the presence of dry or superheated steam.

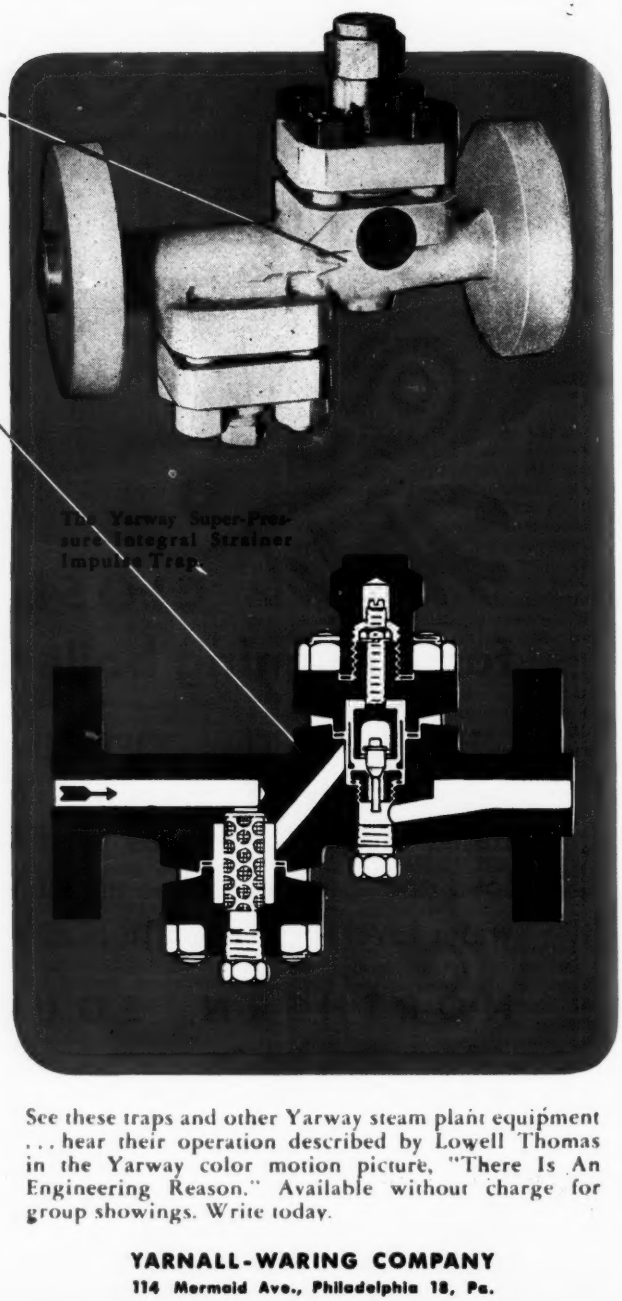
It is a fraction of the size and weight of other type traps designed for the same service—saving space simplifying installation and requiring no supports.

It is suitable for all pressures within a wide range without change of valve or seat.

It has the same simplicity of design as does the standard Impulse Trap shown below—only one moving part, the same little valve.

Its integral strainer protects trap against scale and rust in the piping system.

Available with flanged or socket weld connections. Write for Bulletin T-1739.



The Yarway Super-Pressure Integral Strainer Impulse Trap.

The Standard Yarway Impulse Steam Trap. Note only one moving part — a little valve.

See these traps and other Yarway steam plant equipment . . . hear their operation described by Lowell Thomas in the Yarway color motion picture, "There Is An Engineering Reason." Available without charge for group showings. Write today.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

LETTERS TO THE EDITORS

WAGE RATES

HAVING SUPERVISED electrical maintenance work for the past 25 yr in various plants and locations, I believe I have lived long enough to appreciate the attitudes and aptitudes of skilled mechanics under both standard wages and rates set by supervisors. I do not for one minute advocate the return of the old systems where any straw boss could set the rate, but I do believe we are still a long way off the best highway to good craftsmanship and justice to the worker.

Not long ago I asked a maintenance man why he did not try to improve himself, to do better work. His answer was, "Why should I?"

He pointed out men with far less experience, less skill, less knowledge of the trade, requiring more supervision and instruction, yet drawing the same rate of pay.

This man's rate of wages is not arrived at by any personal standards of ability, his wage rate bears no relation to the service he himself renders to his employers, of this fact he is very, very much aware. Any increase or decrease in that wage rate will depend on factors over which he has practically no control, of this fact he is also very, very much aware. He is also aware of the fact that only one man is intimately acquainted with his personal ability and his lack of ability and that man has no power to alter his wage rate, so why worry? Why improve? His interests and extra efforts go to his hobbies, outside jobs, there he finds rewards in proportion to his efforts and his skill, that is what every man enjoys, he likes to work for some personal gain, not just an employer.

One has but to talk to any supervisor of standard wage rate employees to realize that something must be done to encourage these men to do better work, to render a more efficient service, to improve their skill, not through fear of losing their jobs, but simply because it pays back in cold cash. That is the basis of all business success, yet these same business men sit down and draw up contracts that destroy these obvious factors that are just as effective in labor as in business.

The age-old howl against wage differentials is that it leads to discrimination. *What's wrong with wage discriminaton? Why should we not discriminate between good and bad worksmanship?*

What do we buy or sell without discriminating? We classify, grade, weigh, inspect and test everything we eat, wear and use. We as individuals, ask for prices and estimates on labor which we hire, we want to be sure we are going to get our money's worth, but if one suggests such a clause in a labor contract, he is considered nuts.

Would any business man or union leader suggest that all cars or any other commodity, regardless of its ability to perform, be sold at a set price? Craftsmen are not equal in ability, personal ambitions or intelligence, nor do they have the same capacity or willingness to work. Too frequently, experience and length of service give no sure index of ability or willingness to perform on the job.

Who should pass upon the relative merits of mechanics working for standard wage rates?

Well, if the man's immediate foreman is not capable of passing that judgment as to the value of service rendered in relation to some set standard, then perhaps what we need is new foremen. Whatever changes are necessary, we must soon adopt a system of wage adjustments that will encourage the ambitious and discourage the shiftless workers, a system that will not so strangle a man's ambition that the question of self improvement leaves him with but one answer, "Why should I?" Let's find the answer for him.

Troy, N. Y. GILBERT LINDGREN

ADDITIVES

I READ WITH interest the article on Fuel Oil Additives in the February issue of POWER GENERATION because it is a subject that, I wish could be thoroughly thrashed out by operating engineers who have had practical experience with it.

There are so many different additives available with such great claims made for them that it is hard to tell the good from the bad.

Many claims are made, but after using several different brands of treatment I fail to find the claims justifiable. I find no difference in the flame, no lowering of the flue-gas temperature and no difference in the amount of condensation in the tank. As for the sparkling and a cleaner firebox, I find that an adjustment on the burner will prevent more sparks than the additive, and the soot disappears with a good hot fire, additives or no additives.

I have found, on opening the suction strainers that they were covered with a tough fibrous lint that seems to be present in all No. 6 oil. It is the lint that plugs the strainers.

I opened a tank that had received plenty of fuel treatment only to find 15 in. of *muck* in the bottom that had to be pumped out with a special pump, it was so heavy and gooey.

There are several questions that might bring interesting answers, such as:

1. Just what is sludge, and what does it look like?
2. If there is no sludge available how can one tell what effect the treatment will have on sludge?
3. Is it true that if no water is allowed to collect in the tank no sludge will form?
4. By what means can the operator tell the treatment is working?
5. How can one prove that the treatment is eliminating water in the tank, thereby preventing corrosion?
6. Are there simple tests that will prove the additive is good?

I would like to start a discussion by saying that it is better to clean the tanks mechanically every two or three years because it is cheaper (fuel treatment cost is much too high) and more effective. Lint, sand, and grit cannot be removed by additives.

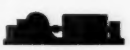
Hope we can have a real good discussion on this subject.

Chelmsford, Mass. CLARENCE W. HOPE

► **Mr. Hope's letter is one of several that we have received, commenting on this subject—all from operators. Like Mr. Hope, most of these operators expressed dissatisfaction in the use of additives; some, deplored the lack of specific information regarding additives for different oils. An operating engineer likes to know something about a product—its composition, factors to consider in its selection, etc. Others asked for lists of additives for specific purposes.**

So, as Mr. Hope asks, let's start a good discussion of these additives. Tell about your experience with them. If we all work together maybe we can shed a little light on the subject. —Ed.

THERMAL EFFICIENCY



IN THE Practical Engineer section of the January issue we are confronted with a dispute on thermal efficiency between a representative of a manufacturer of turbine generators and a member of the teaching profession.

I am an ex-professor of prime mover and power plant design and an ex-employe of the same company

(Continued on page 84)

Designing Safety Into Power Plants and Their Equipment

By P. L. G. HASSKARL
Safety Engineer,
Pennsylvania Power
& Light Co.

To reduce power plant accidents, safety must be designed into plants . . . How to get proper illumination to prevent accidents . . . Adequate working space and clearance from electrical equipment . . . Design of platforms, balconies, railings for safety . . . Guards and precautions on electrical equipment . . . Floor levels . . . Safe handling of equipment during maintenance . . . Report of Accident Prevention Committee analyzes accidents, shows need for designing safety into plants

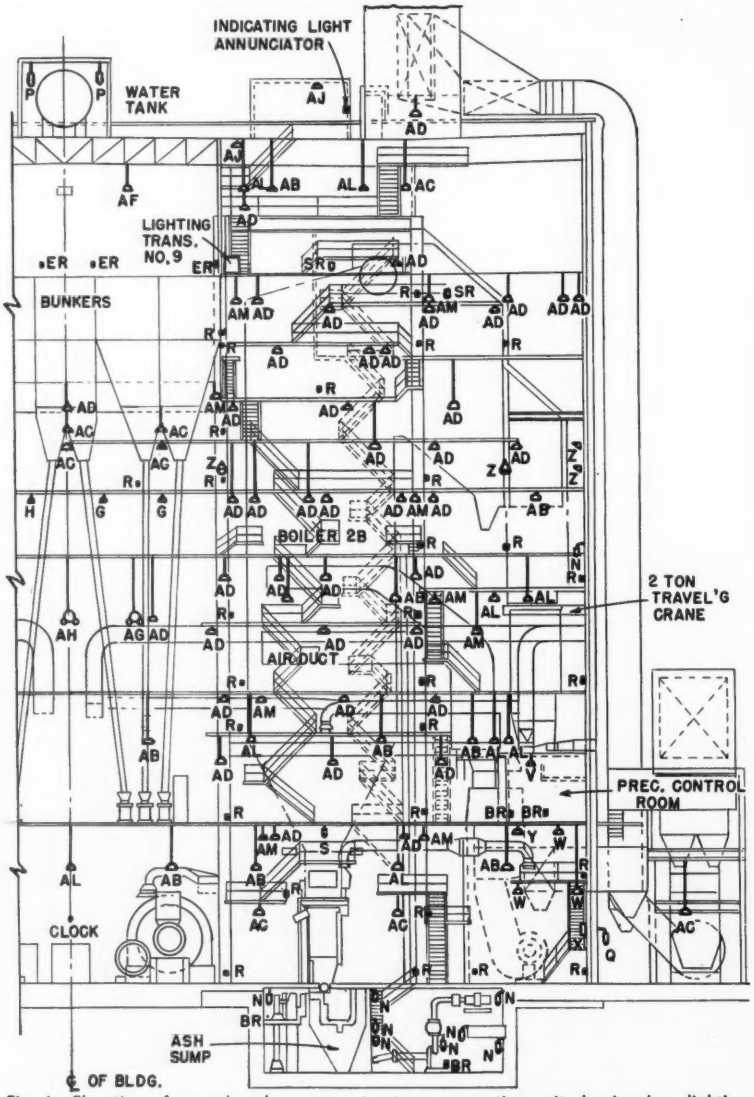


Fig. 1. Elevation of a modern large-capacity steam generating unit showing how lighting has been arranged to prevent accident-provoking shadows on stairways and passages

AM—Over-the-mirror type of reflector
AD—High-bay prismatic glass reflector
AB—Low-bay prismatic glass reflector
AC—Same as AB*
AF—Vapor proof porcelain enamel reflector
AG—Same as AD*
AL—Emergency light P.A.R. lamp
AJ—Enclosed prismatic glass reflector refractor
P—Vapolet
SR—Switch
N or Z—Pit light
AH—Same as AJ*
* Different letters used for different type hangers.
ER—Convenience outlet
R—Lighting receptacle
BR—Power receptacle
V—Dome Reflector—Pendant type Vaportight
W—Same as V†
X—Exit Sign—surface type
Y—Same as V†
G—Continuous Row Type Fixtures—Fluorescent
H—Exit Light
S—Vaporlet Pendant type
Q—Same as S
† Same type of fixtures with different wattage.

RECENTLY RELEASED was a study of generating station accidents, covering a period of 24 months and detailing 285 accidents, of which 185 involved lost time, and 100 no loss of time. Included in the 185 lost time cases were 6 fatalities. The total days charged to the 185 accidents was 43,441—the equivalent of 20 men for one year.

It is significant to point out that the generating stations on a statewide basis, have 38 to 40 per cent of the lost time accidents, whereas the hours worked by generating department employees are only 20 to 25 per cent of the total exposure hours. The transmission and distribution department employees have 25 to 36 per cent of the lost time accidents with 20 to 25 per cent of the exposure hours.

On the premise that the men in the power plants are as intelligent, as skilled and safety-conscious as the men in the transmission and distribution departments, and that the hazards encountered in these departments are comparable, why do more accidents occur in the plants?

Influence of Older Plants

Design of steam electric stations and their equipment, and design of lines, substations and underground networks have progressed on an equal basis. However, it is a recognized fact that there are more steam electric stations of old design in service than lines, substations and underground networks. The designs of the old plants, together with additions and changes made in the equipment, have created limited operating, maintenance and repairing space, with attendant hazards for the workmen. Another factor in the generation department accident record is that one generally finds the less skilled men doing the most hazardous work, with the exception

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This article was originally presented as a paper before the Prime Movers Committee of the Pennsylvania Electric Association and is published here for the first time.

The study referred to in the first sentence was entitled Generating Station Accidents, by the Accident Prevention Committee, Pennsylvania Electric Association, covering a period from January 1, 1943 to December 31, 1944.

Fig. 2. Front view of safety barriers for disconnect switches, A, B and C phases, lower compartments

Fig. 3. Side view of safety barriers for disconnect switches, A, B, and C phases, upper compartments

Fig. 4. View of 12-kv switch gallery, upper compartments, disconnect switches with safety barrier in position. Barriers constructed as in Fig. 3

of electric repair and maintenance crews.

In enumerating the above statistics and conditions, it is not for the purpose of excusing generation department accidents, but to bring out recognized facts and conditions in which design is an important factor.

The study referred to herein showed that 20 per cent of the accidents occurred in coal and ash handling; 18.2 per cent in boiler operation; 14.7 per cent in boiler maintenance; 7 per cent in turbine maintenance; and down the line of various groups to the electrical maintenance men with 3.5 per cent; electrical operation 1.4 per cent. Note that the electrical maintenance and operation showed a low percentage of accidents. However, it must be kept in mind when accidents occur in these departments, they are usually serious or fatal. These figures indicate the need of designing safety into equipment and providing adequate working space, adequate appurtenances and devices for safe operating, maintenance and repairs of the equipment to reduce generating station accidents.

Safety Must Be Considered in Design

Based on accident experience in steam electric stations, the following general safety items were not given proper consideration in designs. The failure to do so has contributed to a marked degree to personnel accidents in plants.

Illumination

(MINIMUM of 25 Foot Candles)

A. At entrances and exits to the building—inside and outside.

B. At all stairways, walkways and aisles, and the lighting so arranged that the users will not cast a shadow while walking on walkways or in aisles and in ascending or descending stairways or ladders. How this is being done in a new power plant is shown in Fig. 1.

C. At all locations where outside work will be done at night—such as coal handling, ash handling, coal thawing, inlet and outlet of water supply and at trash racks. Plant railway tracks should be well lighted due to the hazards in railroading at night and foot hazards which are present in this operation.

D. At entrances and exits to switchrooms, bus rooms, switch cell rooms and transformer rooms; the aisles and passageways in these rooms should be well lighted and the area around the equipment, so the warning and other signs can be clearly seen and easily read.

E. At all locations around boilers, their control switches, valves, gages, and at other locations where the operator must go to make routine checks and perform routine duties.

F. At turbines in pump rooms and similar locations where routine work requires the operators to move around or back and forth while

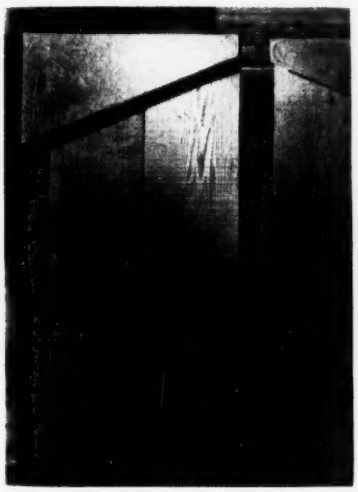


Fig. 5. Safety barriers for lower compartments, A and C phases, side view. Figure 2 shows front of barriers. Method of use shown in Fig. 6

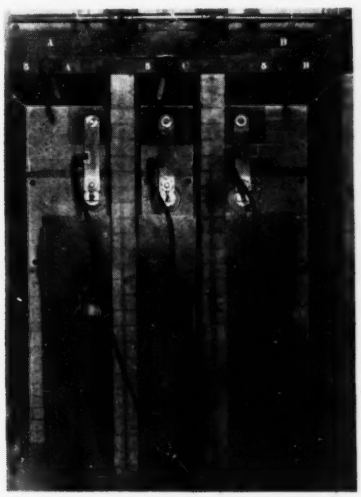


Fig. 6. View of 12-kv switch gallery, lower compartments, with safety barriers in position. Front and side views of barriers and construction shown in Figs. 2 and 5

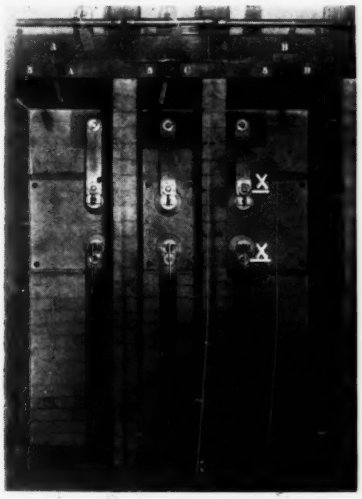


Fig. 7. View of 12-kv switch gallery, disconnect switches, without safety barriers. Ground lugs at X when required and sufficient clearance available

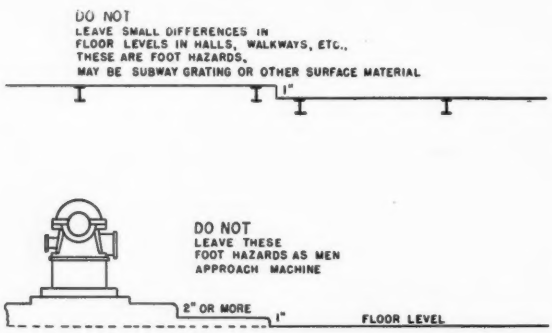


Fig. 8. (Left) These are foot hazards. DO NOT leave small differences in levels of horizontal gratings on floors; or around machines, to cause men to stumble as they approach machine

performing their regular duties.

G. A sufficient number of outlets for extension light cords, of proper capacity, should be provided at all locations in the plant where repair or maintenance work may be done. See Fig. 1. Also, provide outlets to accommodate large electric-operated portable tools and equipment.

It should be kept in mind when designing the lighting that there are times when the operating personnel must move quickly and accurately, especially in emergencies. In such cases, good lighting justifies its cost.

Working Space

Sufficient working and operating space should be provided around all mechanical equipment and electrical equipment. The accident rate of plant repairmen, maintenance and operating workmen shows a marked decrease when they have proper work space around equipment to overhaul, repair and operate it.

Clearance from Electrical and Mechanical Equipment

Passageways, aisles and walkways should be free of foot and head hazards.

Electrical equipment clearances should be obtained by vertical or horizontal locations of equipment so workmen will not inadvertently contact it while they are performing their routine operating duties.

Platforms, Balconies and Railings

Platforms and balconies with railings should be provided at all locations where test men will work and where frequent operating observations will be made and, where frequent adjustment and repairs will be made. They should also be provided at oiling and other locations where men go to check temperature of bearings, operate valves, and the like.

Toe Boards

These should be installed as in Fig. 10, under the railing along the edges of every working platform, runway or balcony that is 6 ft or more above floor or ground level, and at openings in floor, to protect persons below from falling objects.

Stairways

These should have proper pitch, with treads all the same height, with sufficient headroom and hand railings free of obstructions. The treads should be of the non-skid type, especially those exposed to oil and grease.

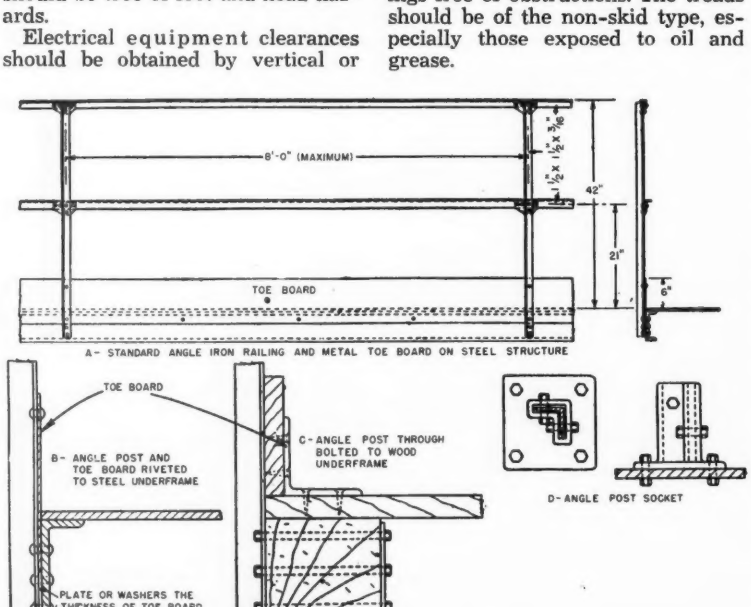

8'-0" (MAXIMUM)
1½" x 1½" x 3/16"
42"
21"
6"
TOE BOARD
A- STANDARD ANGLE IRON RAILING AND METAL TOE BOARD ON STEEL STRUCTURE
TOE BOARD
B- ANGLE POST AND TOE BOARD RIVETED TO STEEL UNDERFRAME
C- ANGLE POST THROUGH BOLTED TO WOOD UNDERFRAME
D- ANGLE POST SOCKET
PLATE OR WASHERS THE THICKNESS OF TOE BOARD TO BE INSERTED HERE

Fig. 10. How toe boards should be installed along edges of working platforms, runways, balconies to keep objects from falling on people below

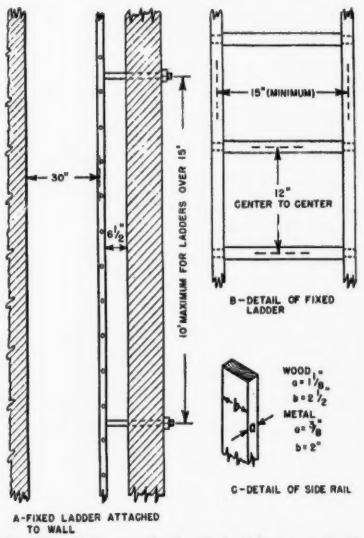


Fig. 9. Safe method of building vertical ladders, with adequate back clearance

Electrical Equipment and Conductors

A. Visible break switches should be provided so the equipment may be isolated and grounded for maintenance and repair work.

B. Provisions for temporary safety grounding should be provided, Fig. 7, either ground switches or ground lugs so the workmen can conveniently and safely connect and disconnect the temporary ground leads.

C. Portable shields or hoods of light weight insulating material should be provided to cover the energized clips or blade sides of disconnect switches in cells when one side is energized, during the connecting of ground leads.

D. Barriers or guards, Fig. 2 to 7, should be installed where electrical equipment is close to aisles or walkways, unless sufficient clearance is provided by elevation of the equipment.

Entrance to Boilers

Entrances at tops and bottoms of boilers should be provided. The entrance openings should be large enough to allow workmen to enter the boilers with tools and equipment necessary to remove slag and make repairs to the interiors of the boilers.

Guards on Machines

All moving machinery should be guarded in accordance with applicable safety codes. In the case of the author's company, this is the Commonwealth of Pennsylvania Department of Industry Regulations and Safety Codes. (The National Codes in some instances, do not conform with those of the State of Pennsylvania).

Fire Hazards

A. Fireproof rooms should be provided for storing paint, oil and other volatile material.

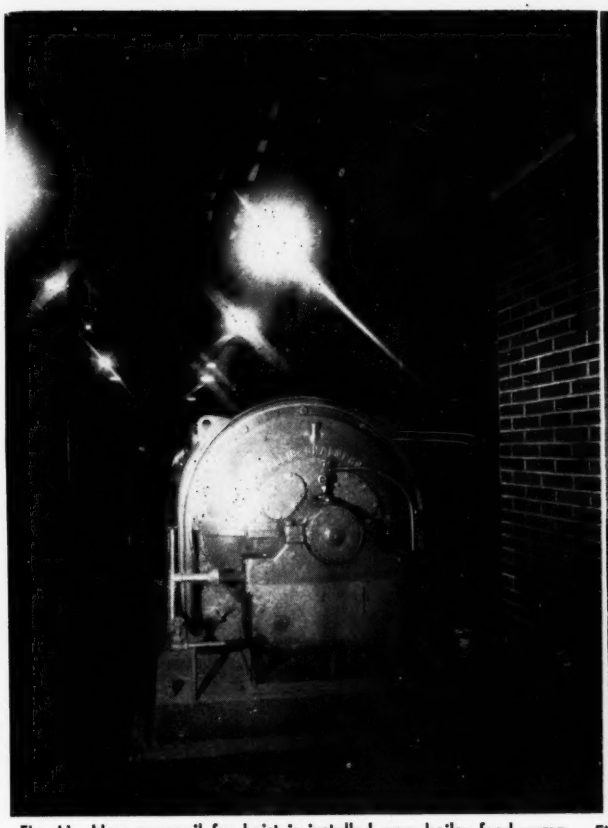


Fig. 11. How monorail for hoist is installed over boiler feed pump to handle parts for maintenance

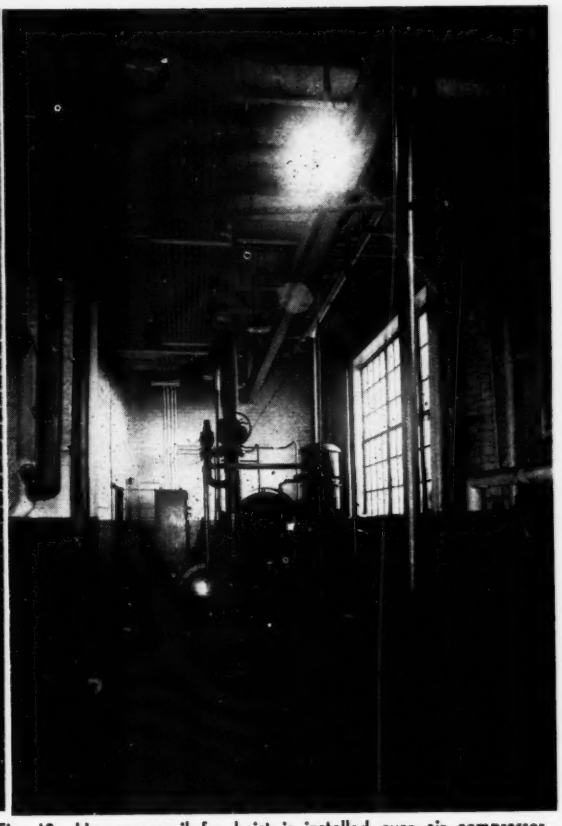


Fig. 12. How monorail for hoist is installed over air compressor to handle parts for maintenance

B. Refuse cans and receptacles, for oily and paint-covered wiping cloths and similar material, should be provided at suitable locations in the plant.

Floor Levels

A. Floors should be designed to prevent different surface levels in a room or section of the plant to eliminate foot hazards, shown in Fig. 8.

B. The top of foundations for machines and equipment should be the same level as the surrounding floor surface when practical, Fig. 8, to prevent workmen from stumbling over foundations as they approach the machines or equipment.

Miscellaneous Items

A. Provide "U" or "Eye" bolts or similar devices, Figs. 11, 12, 13 anchored in ceiling, into which chain or rope blocks may be attached for raising and lowering equipment during its overhauling or repair.

B. When designing fixed ladders for particular locations, provide clearance not less than 30 in. in front of the rungs, and 6-½ in. from the back of the rungs to the nearest object, and not less than 15 in. from centerline of the ladder on either side across the front of the ladder. See Fig. 9.

Failure of engineers to take the foregoing items into consideration in their designs is responsible both directly and indirectly for personnel accidents.

When one designs, he establishes a plan. The plan includes the purpose, type of equipment, space required, its relation to other installed equipment, and its function in the operation of the plant. The plan governs the ease with which the equipment can be operated, maintained or repaired. The easier it is for a workman to do his job, the less accidents he will have with a corresponding increase in production.

Let Operating Men Co-operate in Design

It is the generally accepted practice of today for operating men to carefully study all new designs. They want to know how the equipment will function, how it can be operated and maintained. This is a healthy condition and it will result in safer working conditions with a corresponding reduction in accidents.

The design of new plants today should result in fewer accidents tomorrow because, in most instances, all interested persons are alerted and on the lookout for unsafe operating, maintenance and repair conditions.

Those of us in safety work are also vitally concerned with improving conditions in existing plants and in better designs for additions and changes in present plants, particularly the ones in which space is limited.

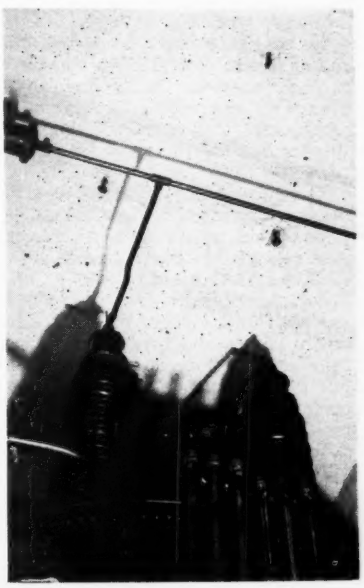


Fig. 13. Eye-bolts set into ceiling over transformer, for hoist to handle bushings only

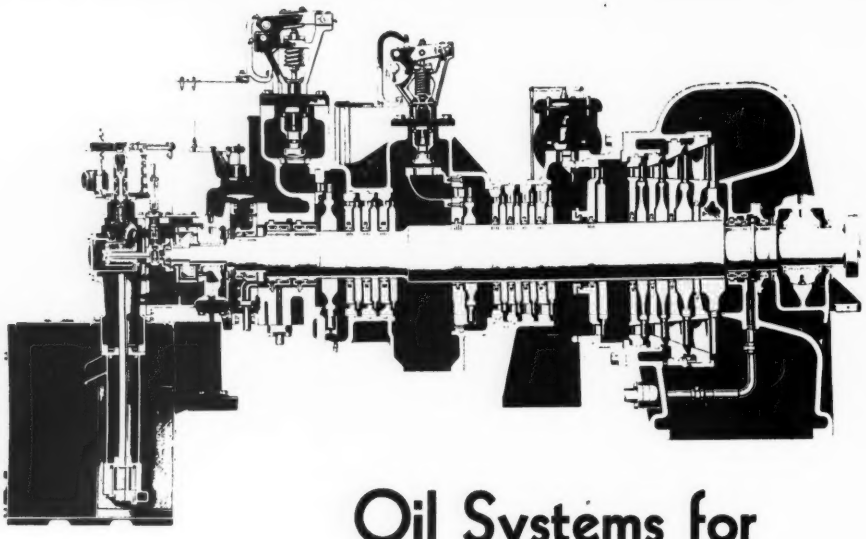


Fig. 1. Cross-section of typical double-automatic-extraction condensing steam turbine as used in industrial power plants

Oil Systems for Industrial Steam Turbines

By **FRANK C. LINN** General Electric Co.

Part I—First of a series of articles on what, why, how, when and where of industrial steam turbine oil systems by one who knows them inside out . . . Only turbines of less than 10,000 kw capacity, of types used in industrial power plants, considered here . . . How turbine oil systems are built and how they supply oil for bearings and hydraulic governors . . . Details of oil system components: main oil pump, governor mechanism, auxiliaries, emergency controls . . . Oil tanks, coolers, conditioning equipment . . . How turbine manufacturer designs and protects oil system for shipment . . . How turbine user should clean system and prepare it for initial charge of oil . . . Future articles will discuss dirt, water, sludge, foaming in oil and how to prevent them; how to determine characteristics of turbine oils and ASTM tests for them . . . Also, what turbine user and operator can do to get right turbine oil, take care of it right, and get best results from it

IN MANY INDUSTRIAL plants, installed steam turbine kilowatt capacity is under 10,000 kw. In such cases, the plant management depends for technical guidance largely upon the manufacturers who supply him with equipment and products. He depends upon the turbine manufacturer and the oil supplier to guide him in the lubricant he uses and on the oil conditioning equipment he installs to complete the lubricating system.

This series of articles presents many of the problems in connection with the lubricating system confronting the operator, suggests some ways of either minimizing or eliminating them, and indicates some of the advancements which have taken place during the past few years in improving the lubricant and the lubricating systems of industrial turbines.

The lubricating system, lubricant, and bearing design for turbines depend upon a number of factors. Analysis of the functions and duties of each is important.

Oil is supplied under pressure to the hydraulic system to actuate the steam valves and to the bearings to lubricate them and carry away the heat. It is passed through an oil cooler to remove the heat and control the bearing inlet oil temperature. The oil may be contaminated with water. It should have low viscosity during normal operation and higher viscosity during starting and stopping. It is usually thoroughly mixed with air in the bearings so that it is oversaturated, and thus foaming, when discharged from the bearing.

The lubricating system is designed to be simple, accessible, and in conformity with good practice.

The bearings are designed to operate with minimum loss consistent with good practice. They operate with relatively small clearance, so they should be supplied with oil free from dirt.

The Lubricating System

The purpose of the lubricating system is to supply clean, air-free oil in proper quantities to lubricate the bearings and to actuate the governing mechanism.

Industrial turbines usually are of the extraction type, either condensing or non-condensing. Cross section of a double-automatic-extraction condensing turbine is shown in Fig. 1. Steam is admitted to the high pressure valves. A portion of the steam is automatically extracted from each of the extraction openings at the required pressures for process purposes. The remainder of the steam goes to the condenser. The governing mechanisms operate so as to admit steam at the high-pressure valves, and to the lower stages at the extraction-stage valves, so as to meet extraction steam demands and electrical load demands. The lubricating system plays a vital part in the functioning of this intricate control system.

Figure 2 is a diagrammatic illustration of an oiling system used on a double-automatic-extraction turbine.

Main Oil Pump

Oil is supplied to the governing mechanism and bearings by gear pump L, Fig. 2. This pump is located below the oil level in the tank and its suction extends into the oil from which most of the air has settled out. Oil pressure for the governing system is controlled by relief valve K, Fig. 2, to pressures of from 55 to 75 psi, depending upon its adjustment to meet design requirements. The oil to the bearing passes through the oil cooler and is throttled by valve M, Fig. 2, to 10 psig.

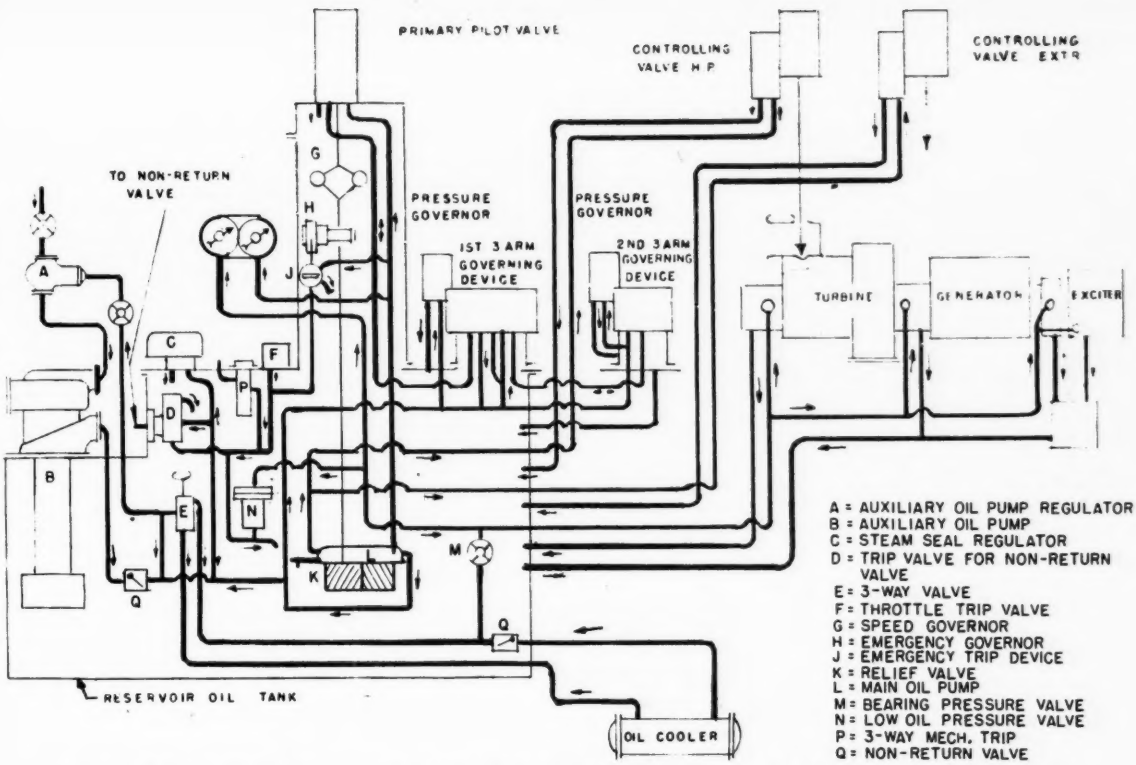


Fig. 2. Oil system for turbine, generator and exciter of a double-automatic-extraction industrial steam turbine generator

The oil pump is driven off the main shaft through a worm and gear, Fig. 5 which are lubricated by oil fed to the mesh from the 10 psi line.

Auxiliary Oil Pump

Part A, Figs. 2 and 3, shows the regulating valve that automatically admits steam to the auxiliary oil pump when the oil pressure drops to approximately 70 per cent of normal pump pressure.

The auxiliary oil pump, Fig. 4 and B, Fig. 2, is used to supply oil during the starting and stopping cycle of the turbine and is available to supply oil whenever the regulating valve automatically operates.

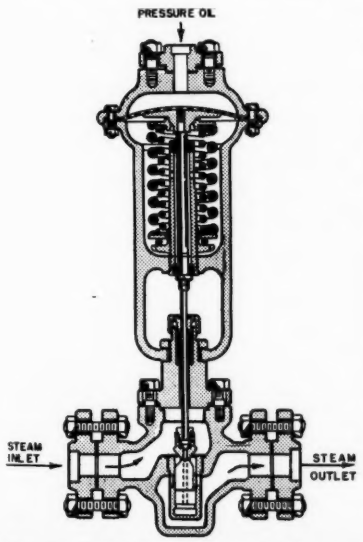


Fig. 3. Regulating valve controlling auxiliary oil pump in turbine oil system

Control Governors

Speed of the turbine is maintained by the speed governor, Fig. 5 and G, Fig. 2, by controlling the inlet steam valves, which admit the quantity of steam required for the turbine to meet its load demand. On some small mechanical drive sets, the governor positions the valves direct through levers. On generating units, the governor positions a pilot valve, which controls the oil pressure under a piston. (Primary pilot valve assembly Fig. 5). This piston positions a second pilot valve, which, in turn, controls pressure under a second piston. (Secondary relay for high pressure valve gear, Fig. 5). This second piston positions the steam valves. In so doing, it is required to operate against forces of many thousands of pounds.

The pressure in the extraction stages is maintained by pressure governors, indicated on Figs. 2 and 5, which position pilot valves that in turn control the pressure under the operating pistons. The operating pistons position the steam valves controlling the quantity of steam admitted to the succeeding stages, and thus maintain the desired extraction stage pressure.

The pressure governors and the speed governor are interlocked by levers and the three arm units, Fig. 5, so as to automatically meet extraction steam and electrical load demands and maintain the speed and extraction pressures within small changes.

Oil is supplied to both the speed and pressure governors, Fig. 5, and is used as one of the hydraulic means for operating the control valves. The requirements of the governing hydraulic system deter-

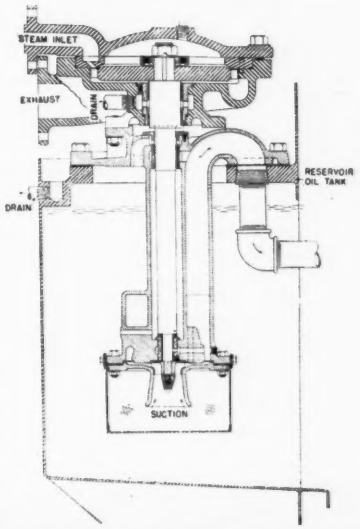


Fig. 4. Cross-section of turbine-driven centrifugal auxiliary oil pump for turbine oil system

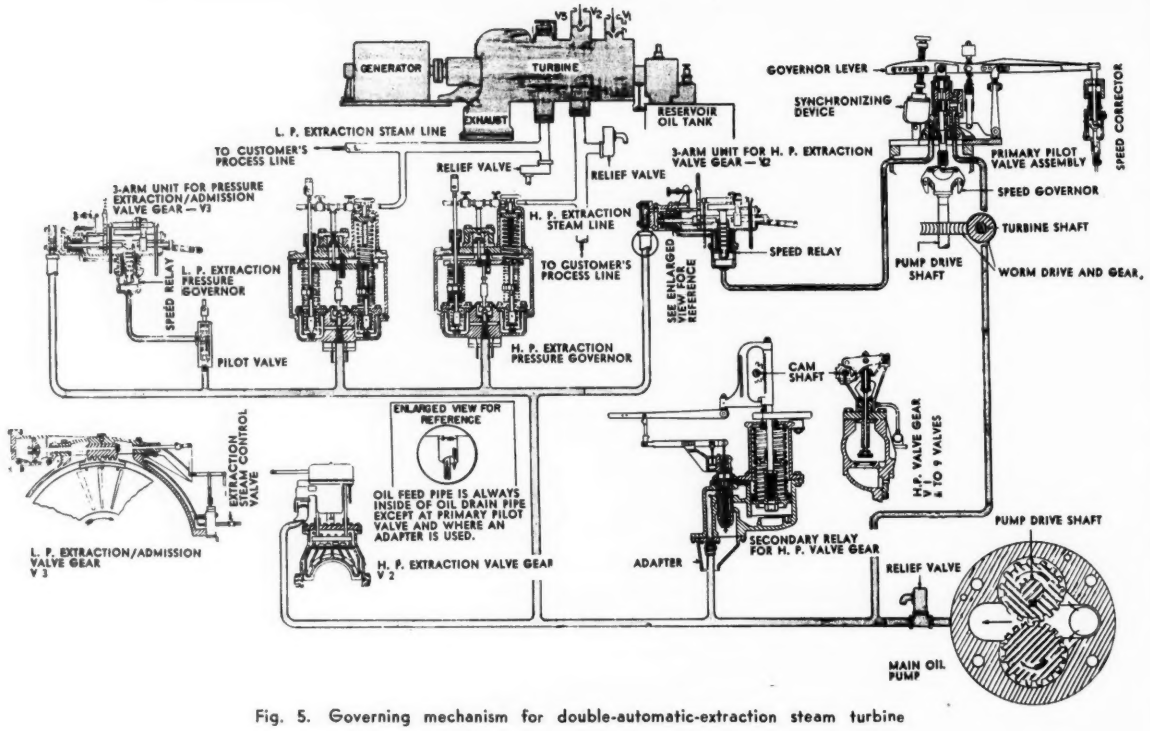

GENERATOR
TURBINE
EXHAUST
RESERVOIR OIL TANK
L. P. EXTRACTION STEAM LINE
TO CUSTOMER'S PROCESS LINE
RELIEF VALVE
RELIEF VALVE
3-ARM UNIT FOR PRESSURE EXTRACTION/ADMISSION VALVE GEAR — V3
3-ARM UNIT FOR H. P. EXTRACTION VALVE GEAR — V2
GOVERNOR LEVER
SYNCHRONIZING DEVICE
PRIMARY PILOT VALVE ASSEMBLY
SPEED CORRECTOR
SPEED GOVERNOR
TURBINE SHAFT
WORM DRIVE AND GEAR
PUMP DRIVE SHAFT
SPEED RELAY
SEE ENLARGED VIEW FOR REFERENCE
H. P. EXTRACTION STEAM LINE
TO CUSTOMER'S PROCESS LINE
SPEED RELAY
L. P. EXTRACTION PRESSURE GOVERNOR
PILOT VALVE
H. P. EXTRACTION PRESSURE GOVERNOR
CAM SHAFT
H. P. VALVE GEAR V1 TO 9 VALVES
ENLARGED VIEW FOR REFERENCE
OIL FEED PIPE IS ALWAYS INSIDE OF OIL DRAIN PIPE EXCEPT AT PRIMARY PILOT VALVE AND WHERE AN ADAPTER IS USED.
EXTRACTION STEAM CONTROL VALVE
L. P. EXTRACTION/ADMISSION VALVE GEAR V 3
H. P. EXTRACTION VALVE GEAR V 2
ADAPTER
SECONDARY RELAY FOR H. P. VALVE GEAR
PUMP DRIVE SHAFT
RELIEF VALVE
MAIN OIL PUMP

Fig. 5. Governing mechanism for double-automatic-extraction steam turbine

mine the main oil pump pressure and capacity.

Oil is supplied to the steam seal regulator, C, Fig. 2. This regulator maintains constant seal pressure in the high and low-pressure packing under all conditions of operation.

The emergency governor, shown on Fig. 6 and H, Fig. 2, is on the main turbine shaft and is set to operate at 10 per cent above normal speed. It actuates the trigger, Fig. 6, when the speed of the unit reaches trip speed. It is essential to electrically disconnect the unit from the line for testing the emergency governor on most units. On other units, the emergency governor is so designed that oil can be admitted to it and it can be tripped with the unit operating with no load but electrically connected to the line.

The trigger, Fig. 6, unlatches the emergency trip valve which closes

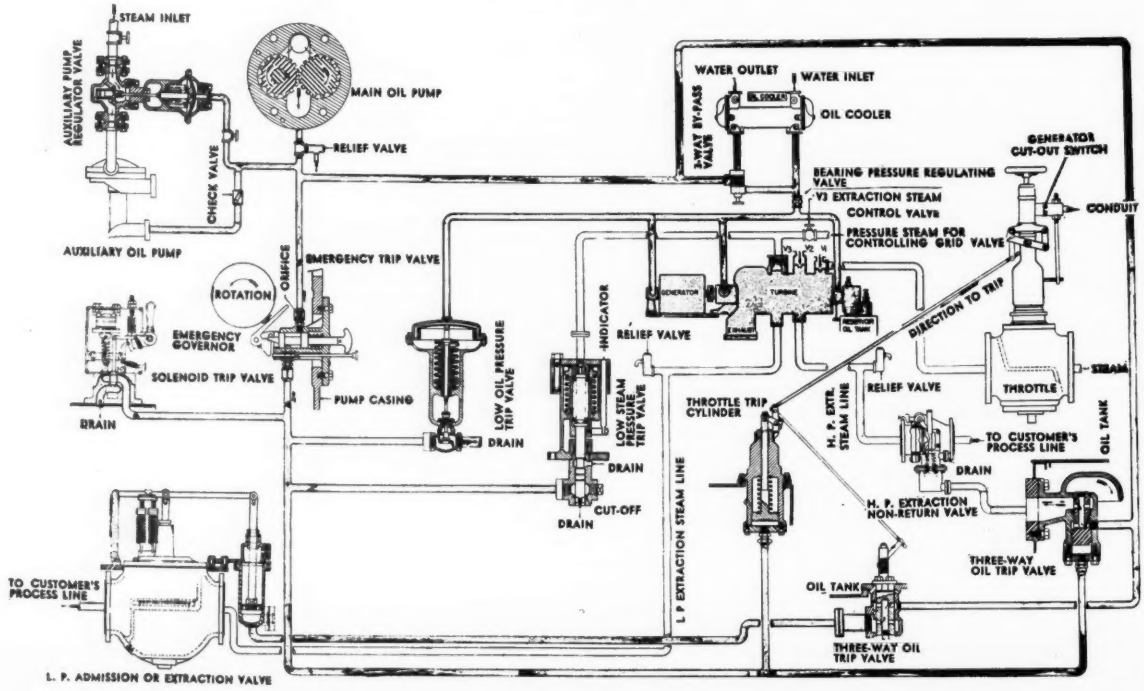


Fig. 6. Emergency governor for steam turbine, showing trip and overspeed protection mechanism

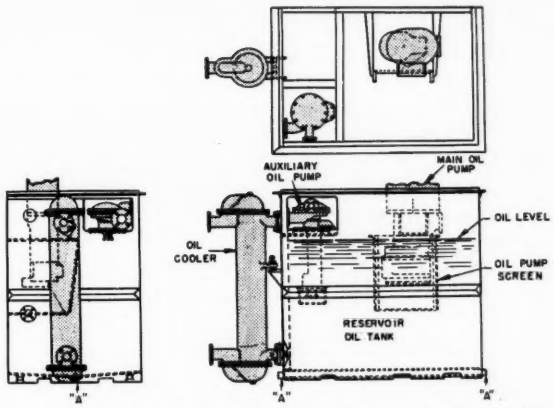


Fig. 7. Typical oil tank for turbine oiling system, showing slant bottom

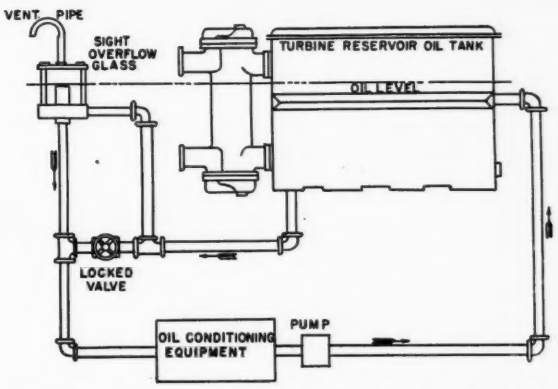


Fig. 8. Typical oil conditioning system for industrial turbine oiling system

off the oil from the pump and discharges oil from under pistons. The piston in the throttle trip cylinder, Fig. 6, trips the latch of the throttle valve. The piston in the three-way oil trip valve closes off pump pressure and discharges oil from under the pistons in the extraction line non-return valves, so that they, in turn, will allow the non-return valves to be closed by springs.

Other protective equipments, such as a low-steam-pressure trip valve, a low-oil-pressure trip valve, and so on are installed on some units to take care of emergency conditions and in which the oiling system plays a vital role.

Although we usually think of the oiling system as being used mainly to supply oil to lubricate the bearings, actually that has become of secondary importance (but still very important) in our modern industrial turbine generator sets. Oil supplied to the control system of the unit supplies the power for the operating governor equipment. The automatic release of oil supplied to the overspeed governing equipment allows spring forces to close steam valves. These shut off the steam flow to the turbine and thus keep the unit from over-speeding.

Knowing the responsibility that the oiling system has in the control and overspeed protection equipments, one realizes the necessity for the proper maintenance of the oiling system and the use of an oil which will not let parts corrode or plug up due to rust or sludge.

Oil Tanks

The oil tank, Fig. 7, is constructed so as to mount the oil cooler, auxiliary oil pump, and the other parts either on or in it. The bottom of the tank is sloped to the center which is shaped to a "V." Drain holes A are provided at either end of the "V."

Turbine generator sets below 1500 kw are mounted on a base and have the tank welded into the base structure. These tanks have oil capacities of from 2 to 4 times the oil pump capacity and vary from 50 gal for the smaller sets to 150 gal for the larger sets.

Turbine generator sets of 2000 kw to 10,000 kw capacity are mounted on sole plates and the oil tank is separate from, but adjacent to, the front end of the turbine. These tanks have oil capacities of over 5 times the oil pump capacity. The tanks range from 200 gal to 1000 gal in capacity.

The oil tank cover is not fitted tightly in most installations and this allows for venting. In chemical and other plants, where it is essential to keep contaminants out of the oiling system, the tank is sealed off, with a connection provided for venting. It is quite essential to vent all oiling systems to allow vapor that collects above the oil in the tank to pass off.

Bearing and Cooler Arrangement

Figure 1 shows the arrangement of bearings on the turbine of an industrial turbine generator set. There is another bearing at the generator pedestal and two bearings in the exciter. Oil is fed at 10 lb pressure to the bearings. The pressure oil lines are inside the front housing or the return oil lines as far as the bearing at the low pressure end of the turbine. The pressure oil line to the generator and exciter bearings is not guarded.

All oil supplied to the bearings passes through an oil cooler, which extracts heat and controls the oil temperature to the bearings.

One or two coolers are supplied on each installation. If and when coolers get dirty, it is essential to correct the condition immediately. Experience indicates that by using inhibited turbine oils and by the proper use of a simple oil conditioning equipment, dirty coolers need not occur.

The preferred arrangement of oil coolers is on the side of the tank, Fig. 7. This arrangement permits the pressure oil joint at the cooler to be a connection inside the oil tank.

Internal Piping

To reduce fire hazard to a minimum, pressure oil piping adjacent to the turbine has been enclosed in the return oil lines or in the oil tank. (See enlarged view reference, Fig. 5.) Pressure piping in the return lines increases the problem of cleaning. However, if inhibited oils are used and changed previous to having the oxidation inhibitor used up, the necessity for cleaning the pipes is remote.

Materials

Materials most commonly used in lubricating systems are cast iron, low carbon steel, copper and copper alloys. These materials act more or less as catalysts. However, inhibited turbine oils that do not give an acid number of over 0.25 for 1000 hr in the ASTM oxidation test should give years of life in the lubricating systems of industrial turbines.

Materials such as aluminum, tin, and the like are not catalysts. However, they are structurally unsuited or relatively expensive and their use is either unsuitable or not justified in the structural portion of the system.

Oil is one of the cheapest materials used in a turbine. Inhibited oils will give long life if given reasonable care. Replacement of the oil previous to the using up of oxidation inhibitor will insure a clean system and allow the use of the less expensive and/or stronger materials in the lubricating system.

Conditioning Equipment

When a unit is placed in operation, the oil must be maintained in proper condition to obtain dependable operation and long oil life. The lubricating system must be free of contaminants such as water, solid materials, and oil deterioration products. This can best be accomplished by operating on a continuous by-pass conditioning equipment. Figure 8 shows a typical oil conditioning system.

The oil supply line to the conditioning equipment should be con-

(Continued on page 112)

Placing A New Refrigerating Plant in Service

After the equipment is delivered a lot of work has to be done. Things do not always fit, parts are damaged and some do not arrive on time. Substitutions have to be made. Control devices have to be adjusted, foundations have to be made. These and a thousand other details make up the work of the installing engineer. Mr. Holman tells how it was done at Pana, Ill.

By GEORGE HOLMAN

AT THE CLOSE OF THE WAR the Equity Union, a farmers cooperative dairy, planned the erection of a new plant near their old plant at Pana, Illinois. Amid shortages of all kinds erection began late in 1947. Except for brick and tile work, little progress was made during the winter and early spring. By July 1, 1948, however, the cold storage had been corked in, and the refrigeration equipment began to arrive.

On July 15, installation of the two refrigeration systems was begun. A superficial check of equipment and parts revealed a shortage of pressurestats, solenoid stop valves, float type expansion valves, heavy duty pipe in correct sizes, ammonia stop valves and numerous ammonia pipe fittings. These shortages were expected. In order to get the corked rooms refrigerated as quickly as possible, the following expedients were resorted to.

1. Temporary substitution of equipment that had arrived for that which had not arrived: When pressurestats for compressor control failed to arrive, two pressurestats intended for condenser fan and recirculating water controls were used to control compressor operation.

2. Low cost items were purchased for temporary service. When the system was ready for the pressure test, for example, the float type expansion valves for the floor set evaporators had not yet arrived. The 3 in. pipe end inlets were sealed off with caps bought for the purpose. When the system was first put into operation these caps were left in place, and liquid ammonia fed through manual by-pass expansion valves.

3. Some equipment, not having arrived, was temporarily left out of the system. For example, the solenoid stop valve in the liquid line to the sweetwater cooler was left out for a time, and the float type expansion valve of this unit depended upon to hold during long off cycles.

4. Pipe sizes were changed. When it was found that not enough 1¼ in. double strength pipe was available for a small vajor line, 1½ in. pipe was used part way.

5. Due to the absence of electrical equipment, such as solenoid stop valves, pressurestats and thermostats, the electricians could not complete the wiring. Conduits were erected, however, and the wire pulled in and the ends taped off.

6. Material intended for other than refrigeration uses was used as temporary substitute: When galvanized pipe for water lines to condenser and machine jackets failed to arrive, a temporary pipe line of black pipe was run from the water meter to the compressors and thence to the condenser for makeup. This made possible the running in of the compressors and refrigeration of the storage at the earliest possible date.

7. When rods for pipe hangers could not be procured, sizes No. 9 and No. 10 wire was used for temporary support.

8. Ammonia pipe fittings varied in size from ¼ in. to 2½ in. Except for the surge drum connection to a sweetwater cooler, all fittings were threaded. These fittings, although unused, were old and weathered. Many of the threads were rusty and dirty, or scarred. Threads were cleaned by running in taps until reasonably tight, then washing out the rust and dirt with gasoline. For this purpose gasoline is superior to many commercial solvents because it readily evaporates.

9. All factory threaded pipes and nipples were inspected. When deemed necessary, these were rechased with dies, then cleaned with wire brush and gasoline.

10. All pipes were swabbed clean

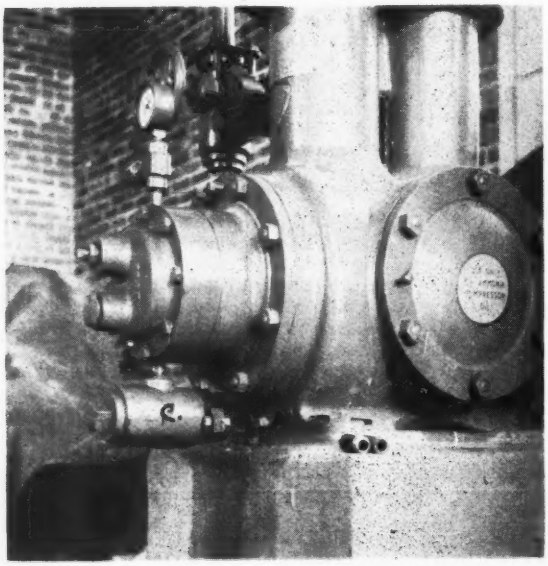


Fig. 1. Broken pipe nipple of compressor oil system. A. Crankcase inlet. B. Oil pump inlet. C. Filter

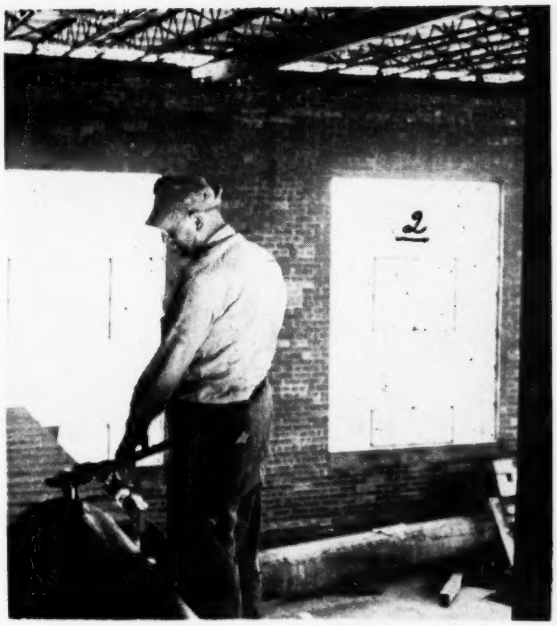


Fig. 2. Battered surge tank outlet being retapped

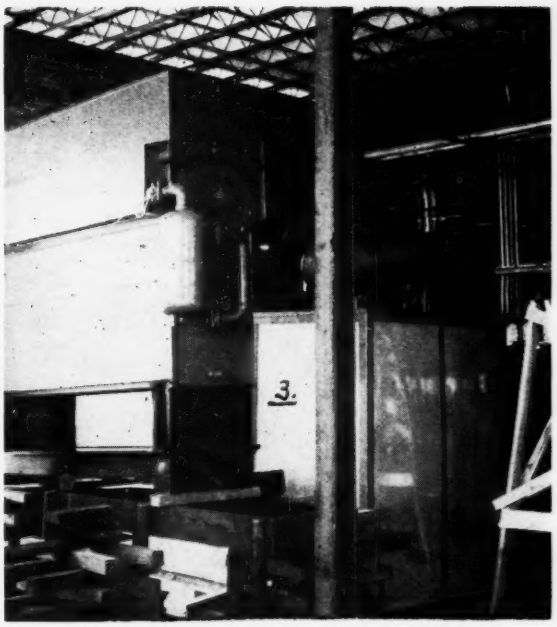


Fig. 3. Topheavy evaporative condenser cribbed up

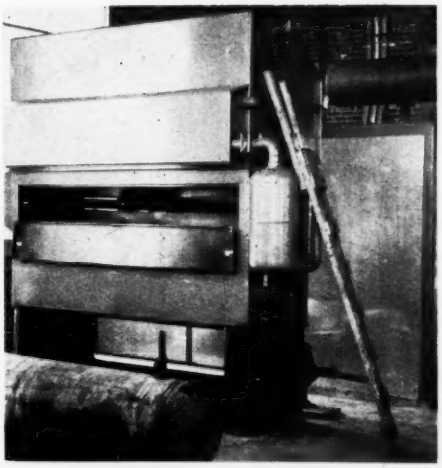


Fig. 4. Condenser after lowering to floor

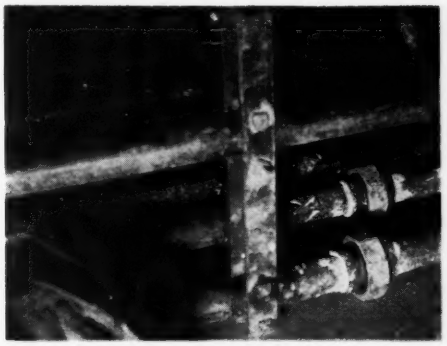


Fig. 5. Method of repairing ammonia coils of sweetwater cooler

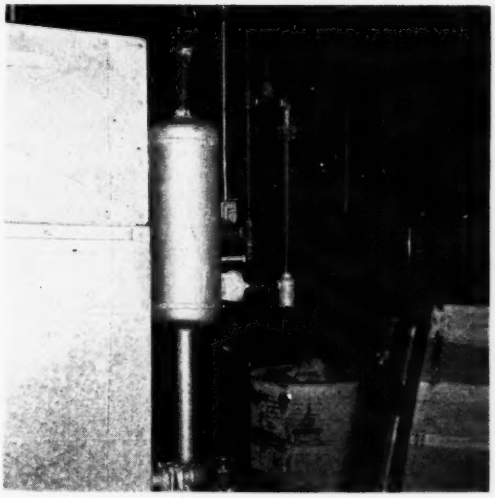


Fig. 6. Piping connections of forced circulation evaporator

Fig. 7. Threading large pipe by use of power vise and universal shaft

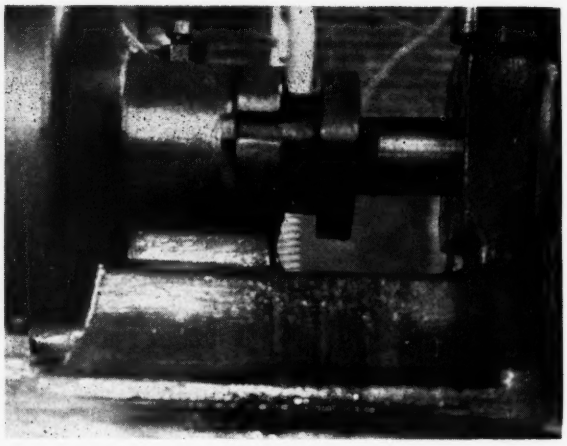


Fig. 8. (Left) Charging ammonia into system

Fig. 9. (Above) Oil and ammonia leak of shaft packing

Fig. 10. (Above) This pressure gage "lost face"

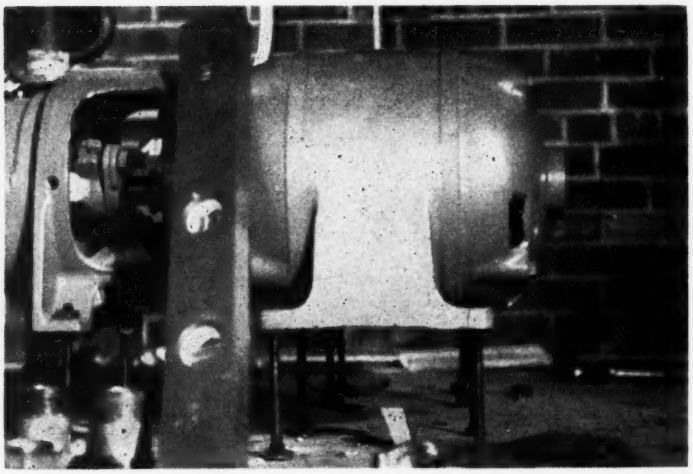


Fig. 11. (Right) Method of leveling sweetwater pump

by drawing a shop towel or rag on a messenger wire through each length before cutting, threading, or putting into service.

11. Bonnets were removed from all valves, and seats and gaskets inspected. One 2 in. valve was found with a steel clipping pressed into the lead seat. The clipping was removed, and the lead disk repuddled by melting with the oxy-acetylene blowpipe. Lead was added and, after cooling, the excess lead was rasped off.

12. The ¾ in. coupling type outlet from the condenser for the equalizer line was found to be welded to that vessel at an angle. This required double-elling to level off the horizontal run of equalizer piping.

13. The ¾ in. and 1 in. nipple type outlets of the liquid receiver for the oil blowdown, gage glass and equalizer line connections had all been damaged at the threads. All were too short to rechase with standard die heads. Solid block dies were used, and turned on with wrenches.

14. Plans had been drawn to set the receiver directly under the condenser. Since no condenser base had been provided, a condenser sub-base was welded together of channel iron and 3 in. pipe. The condenser was raised with jacks, and cribbed up preparatory to setting it on the subbase. However, all refrigeration men present pointed out that the top-heavy condenser would require a firmer base, or be a menace to the piping systems attached to it. The owners accepted the recommended change, and the condenser was lowered to the floor. This made necessary the setting of the receiver at one side of the condenser. Upon this writer's recommendation, the receiver was set outside the direct circuit of the refrigerant, as a reserve tank.

15. The topheavy evaporative condenser set on four supports rising from the corners of its own drain pan. In shipment, the pan had cracked open at each of the four supports. These breaks were repaired by welding.

16. The forced-feed lubricator of the 6½ in. by 6½ compressor was found to be heavily fouled by grit. It and the oil tubing leading to the cylinders were removed, and thoroughly cleaned with a solvent.

17. When setting the 5 in. by 5 in. compressor, an oil leak was discovered at the crankcase end of a ½ in. pipe nipple connecting the oil filter to the compressor. Upon removing the oil pump, the threaded end of the nipple was found to have broken off inside the tapped hole into the crankcase. The broken off piece was set hard in litharge, and had to be cut off. After its removal by expert cutting with a small diamond point chisel, the hole was retapped to clean up the threads. Due to this operation, a nipple of the same length as the old one proved to be too short, since it screwed too far into the hole. A special nipple was cut, with careful allowance for tightening. The author dislikes this type connection for oil pumps and filters. Mechanical precision of a pipe system is required, and when replacing the pump the pipe union must be tightened simultaneously with the stud nuts.

18. Inspection of the sweetwater cooler showed that the welded-on 2 in. coupling type outlet had been battered out of round during ship-

ment. The threads were recut with a 2 in. pipe tap screwed in with a 36 in. pipe wrench.

19. The high side safety valve was left off, and the outlet plugged, until that side of the system had been tested at 250 psig. Three slight leaks accounted for part of the 20 psi pressure drop within 36 hr. Cooler weather was partly responsible for this drop.

20. At first try, the low side pressure, pumped up in 10 psi stages, could not be raised above 30 psig. Air whistling out of the sweetwater cooler betrayed a serious leak there. This vessel had not been tested thoroughly before leaving the factory since a return bend was found to have cracked during the bending procedure. To avoid lifting the coils from the tank, an attempt was made to weld the crack. The welder could not reach the under side of the bend, and on second test the coils still would not hold. The return bend was cut off with a hacksaw, the 1¼ in. pipe ends threaded with a standard tool. An impromptu return bend was made of two ells and a nipple, and the bend set in with two pieces of pipe and unions. After this method of repair, the coils held under 150 psig air test.

21. Floor set, flooded type forced air circulation evaporators were installed, with backpressure regulators and solenoid-operated stop valves on both liquid and vapor return lines.

22. All pipes were threaded with power tools, a universal shaft being used to thread all sizes over 2 in.

23. 900 lb of ammonia was charged into the system. As nearly as possible, stop valves were placed within easy reach of the plant operator.

24. During the first night the 5 in. by 5 in. compressor was left in operation a fuse blew and idled this machine several hours. The high and low side pressures equalized at 120 psig, and oil with ammonia leaked from the crankcase through the shaft packing.

25. After a week in service, the face of a high pressure gage began to turn yellowish-brown. The enamel became sticky, and a faint odor of ammonia betrayed a leaky bourdon tube when the gage glass was removed. The face began to run, with the red figures fading out, and the black figures sliding toward the bottom of the gage.

26. No base had been provided for the three sweetwater pumps. These pumps were set up on long bolts, with nuts locking the bolts rigidly to the pumps as legs. Pumps were leveled by adjusting the nuts, then anchored firmly by pouring concrete around the bolts.

27. Electric power was stepped down to 230 v. However, an electrician mistakenly connected the condenser fan motor for 440 v. The motor became hot, but the error was found and corrected before any damage was done. Induction motors are usually designed so that they can be operated on considerable over-voltage for short periods of time, provided they are loaded to full capacity. This evidently was true in this case—the meter was not damaged.

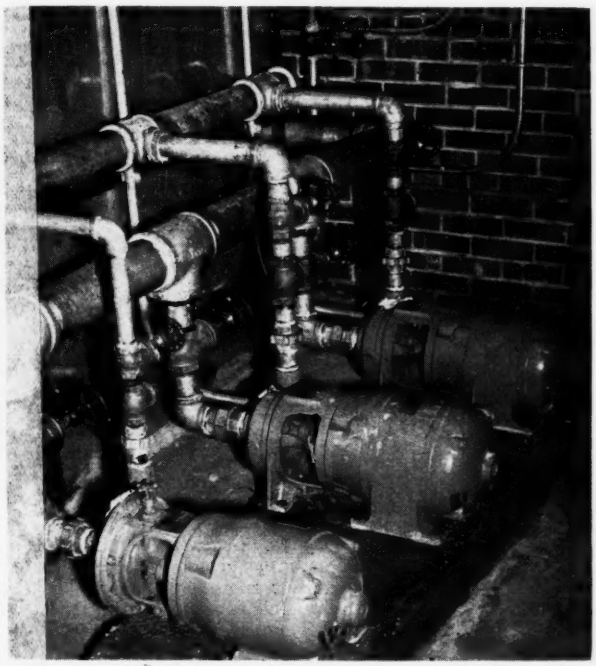


Fig. 12. Battery of sweetwater pumps after concrete block base was poured

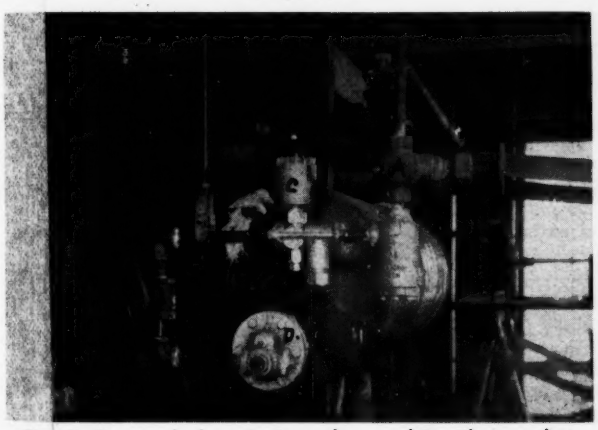


Fig. 13. Surge tank of sweetwater cooler, complete with stop valves A and B, solenoid stop valve at C and float type expansion valve at D

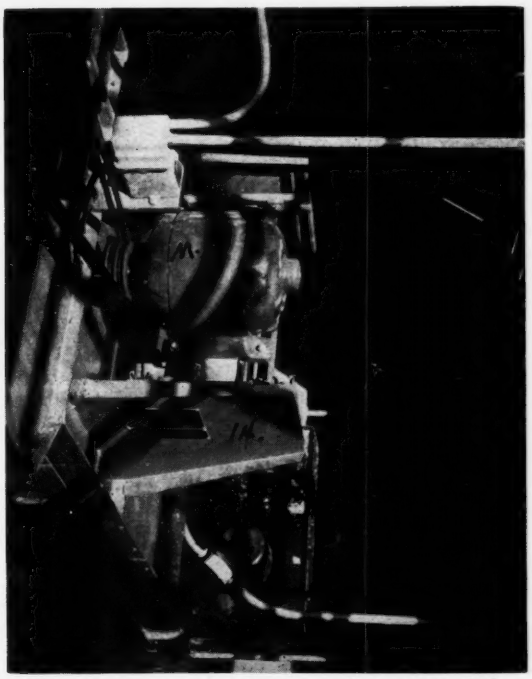


Fig. 14. Fan motor of evaporative condenser at M, which grew hot when wrongly connected for 440 on a 230 circuit

Industrial Applications of Rotating Regulators

The Rototrol—What it is and how it works . . . Rototrol amplification and Forcing action . . . Principle of Two-stage Rototrols . . . Use in Synchronous Condenser Regulation . . . Current limit Rototrols . . . Application of Current Limit Rototrols

By M. H. FISHER
Industry Engineering Dept., Westinghouse Electric Corp.

THE TREND in industry today is toward higher production speeds, more rigid quality control, and automatically controlled operations and processes that eliminate the rather uncertain human element in continuous duplication of results. These factors have made necessary many improvements in control methods and operation and a surprising number of the resulting problems have been solved or simplified by the use of the Rototrol rotating regulator.

The Rototrol is used for the regulation of voltage, current, speed, torque, tension, and numerous other quantities which can be measured electrically. Fundamentally it is similar in design and theory of operation to a standard d-c generator, but has a number of field windings which are connected in various ways in the electrical circuit depending on the regulating problems. It functions entirely through the interactions of these fields, and after once being properly adjusted, gives unvarying and trouble-free service indefinitely with minimum attention.

In physical appearance the Rototrol looks like an ordinary small d-c generator. It is usually designed for operation at high speed to reduce the size and the field time constants. These units may be assembled in motor-generator sets of either the unit-frame or coupled-unit type which can be mounted in any convenient location.

The Rototrol Fields

Any regulating device functions on the principle that the regulated quantity is measured and compared to a fixed standard or pattern. If any deviation from the pattern occurs, the regulator produces the required corrective action to restore the regulated quantity to its original value. When a Rototrol is used for regulation, the value of the regulated quantity, as well as of the pattern, must be converted into proportional voltages which are impressed on windings on the field poles. The windings are connected to oppose each other and are so designed that the resultant magnetomotive force is zero when the regulated quantity is at the correct value. Any deviation produces a definite magnetomotive force which causes a change in the magnetic flux, and consequently, in the output voltage of the Rototrol in a direction to reduce the deviation.

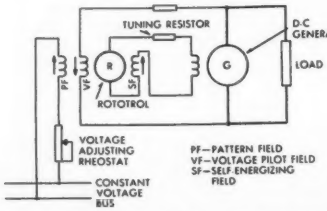


Fig. 1. Schematic of the simplest form of Rototrol rotating regulator

In its simplest form the Rototrol has three fields, as shown in Fig. 1. Here it is being used as a voltage regulator. The function of these three fields is as follows:

Field SF—The self-energizing field. This field, connected in the Rototrol armature circuit supplies the ampere turns necessary to produce the voltage output of the Rototrol; this will be discussed later in detail.

Field PF—The pattern field. This field is energized from a constant-voltage source and serves to set the pattern for the regulated quantity. The value of the quantity, in this case the generator voltage, can be adjusted by means of a rheostat in the field circuit.

Field VF—The pilot field. This provides the means for measuring the regulated quantity and comparing it with the pattern.

For some applications the voltages which provide the measurement for the pattern and the regulated quantity are compared externally to the Rototrol and the voltage difference impressed on a single Rototrol field which then is called the control field.

Self-Energizing Field

To obtain accurate regulation the net ampere turns of pattern and pilot fields must be zero, or close to this value when the regulated quantity is at the correct value. The ampere turns actually required for Rototrol excitation, therefore, must be produced by other means. This is the function of the self-energizing field which helps make it a sensitive regulating device. The effect of the self-energizing field is illustrated in Fig. 2 which shows the saturation curve for a Rototrol.

Adjustment of the resistance (R_1) in series with the self-energizing field is called "tuning" the circuit. For example, if one ampere flowing in the self-energizing field will produce sufficient ampere turns in that field to generate 50 v across the brushes, say at point V_1 on the saturation curve of Fig. 2, and if the resistance of the loop circuit has been adjusted to 50 ohms by adjustment of the tuning resistance R_1, the loop circuit is "self-energizing" or "tuned." The reason for this is, that any value of current flowing in the circuit will generate enough voltage to sustain itself and it is possible for the Rototrol to operate over the straight portion of the saturation curve without the pattern and pilot fields supplying any of the ampere turns necessary to generate steady state voltage. For this condition the steady-state amplification of the Rototrol is theoretically infinite. To obtain satisfactory regulation over the required range, the operation, therefore, is usually limited to the air-gap portion of the saturation curve and the self-energizing circuit resistance line is made to coincide with the Rototrol saturation curve.

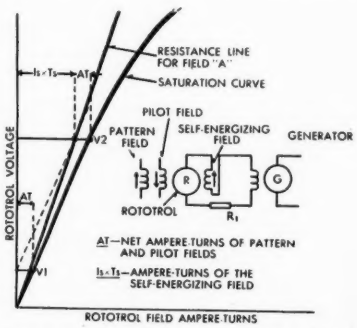
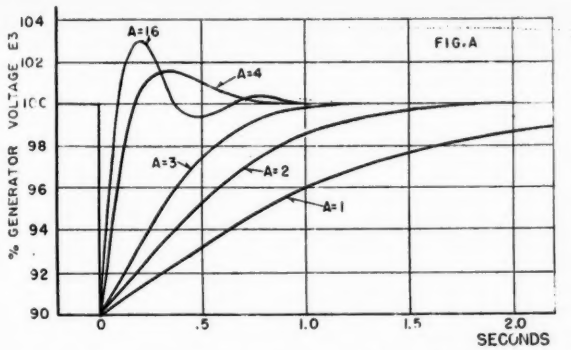


Fig. 2. Saturation curve for Rototrol with self-energizing field

The regulating ability of the Roto-



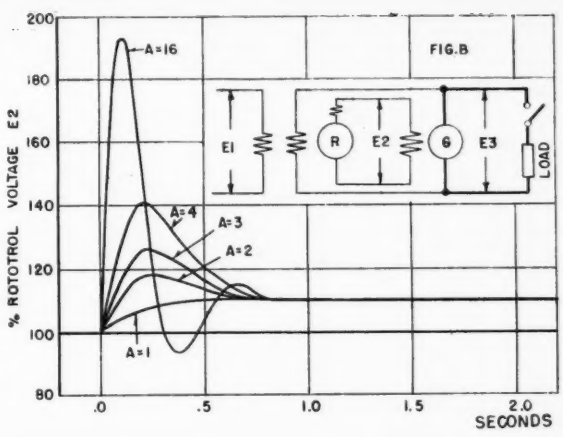


Fig. 3A. Generator voltage as a function of time when full load is applied suddenly to a generator having 10 per cent IR drop

Fig. 3B. (Right) Rototrol voltage as a function of time

trol depends on two factors: (1) the steady-state system amplification that determines the sensitivity and accuracy of regulation; and (2) the dynamic system amplification that determines the speed of response in restoring the value of regulated quantity after a disturbance. The effect of the dynamic amplification is referred to as the Rototrol's forcing action.

Rototrol Amplification and Forcing Action

Amplification can best be defined and illustrated by reference to the voltage regulating system shown in Fig. 1. Amplification on the voltage basis, which should not be confused with power amplification, in this case may be defined as the change in the generator voltage caused by a one volt change in pilot-field voltage. If the amplification factor is 10, a change of one volt in field voltage, therefore, produces a 10 volt change in the regulated voltage.

Dynamic amplification is the system amplification obtained without the benefit of the self-energizing field.

Steady-state amplification is the system amplification obtained with the assistance of the self-energizing field.

Figure 3A shows the generator voltage of the voltage regulating system in Fig. 3B as a function of time when full load is applied suddenly to a generator having 10 per cent IR drop. Curves are shown for dynamic amplification factors of 1, 2, 3, 4, and 16. Note that due to steady-state amplification, the voltage eventually reaches the 100 per cent regardless of the dynamic amplification.

Although high dynamic amplification greatly increases the accuracy during transients, it is apparent from Fig. 3A that it also tends to increase overshooting and hunting.

Figure 3B shows the Rototrol voltage as a function of time. For unity dynamic amplification the net ampere-turns of pattern and pilot fields resulting from the drop in generator voltage are sufficient only to produce the increase in Rototrol voltage required to raise the generator voltage to its 100 per cent value. For higher amplification, however, the resulting net amperes turns equal the value, actually required, multiplied by the amplification factor. As a consequence, the Rototrol voltage builds up rapidly to a value much higher than that ultimately required for generator excitation. The rate of build-up is limited only by the time delay of the Rototrol fields which can be made as short as required by suitable field circuit design. An excess in Rototrol voltage is thus available to force the additional current through the usually sluggish generator field and speed up the voltage build-up. As the generator voltage approaches the correct value, the net ampere turns of pattern and pilot fields approach zero and the additional current through the self-energizing field becomes just sufficient to maintain the generator excitation at the point indicated by the new set of circuit conditions.

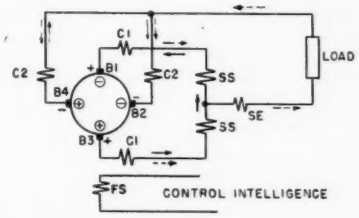
Two-Stage Rototrol

The dynamic amplification of the standard Rototrol as described, cannot be increased beyond a certain limit without excessive power input to the pattern and pilot fields. The obtainable amplification factor, however, is more than enough to provide the sensitivity and speed of response required for all but a few industrial applications. To obtain very high amplification with a low power input, it is necessary to provide two stages of amplification. This may be accomplished by the use of two separate machines: one, a conventional exciter; the other, a Rototrol. However, the preferred method is to use a special two-stage Rototrol, where both stages of amplification are obtained with a single armature.

In an abbreviated schematic diagram the two-stage Rototrol is shown in Fig. 4. Control coil FS is located on two ordinarily like poles. Excitation of field FS results in a voltage difference being produced between ordinarily positive brushes B_1 and B_3. This causes a current to flow from brush B_3 to brush B_1 through amplifying coils SS. These coils are located on the four main poles and have correct polarity to excite the poles alternately North and South. This causes the brushes to be alternately positive and negative thus being able to supply a load in the manner of an ordinary d-c generator. Fields C_1 and C_2 are compensating fields to aid in controlling undesirable fluxes created by the armature currents. Self-energizing fields SE function the same as on a conventional Rototrol. Tests have shown that a 10-kw Rototrol can be controlled over its entire range by a maximum power input of less than 0.1 watt—a power amplification of one-million to one. A typical application of the two-stage Rototrol is as a voltage regulator for synchronous condensers and turbo-generator sets.

Current Limit Rototrol

The current limit Rototrol is a special rotating regulator used in regulating systems requiring limiting features. It does not differ from a normal d-c generator except for special pole pieces as shown in Fig. 5A.



LEGEND
FS-FIRST-STAGE CONTROL FIELD ON POLES P1 AND P3 ONLY
SS-SECOND-STAGE FIELD ON ALL POLES
C1-COMPENSATING FIELDS ON POLES P2 AND P4 ONLY
C2-COMPENSATING FIELDS ON ALL POLES
SE-SELF-ENERGIZING FIELDS ON ALL POLES
---►-LOAD CURRENT
——►-FIELD CURRENT BETWEEN POSITIVE OR NEGATIVE BRUSHES
⊖⊕-RELATIVE POLARITIES OF OPPOSITE BRUSHES

Fig. 4. Schematic of two-stage Rototrol

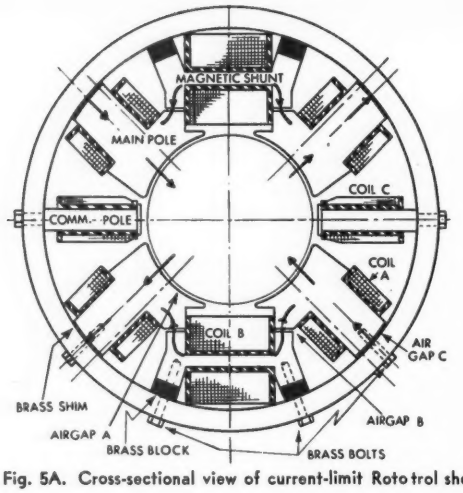


Fig. 5A. Cross-sectional view of current-limit Rototrol showing special pole pieces

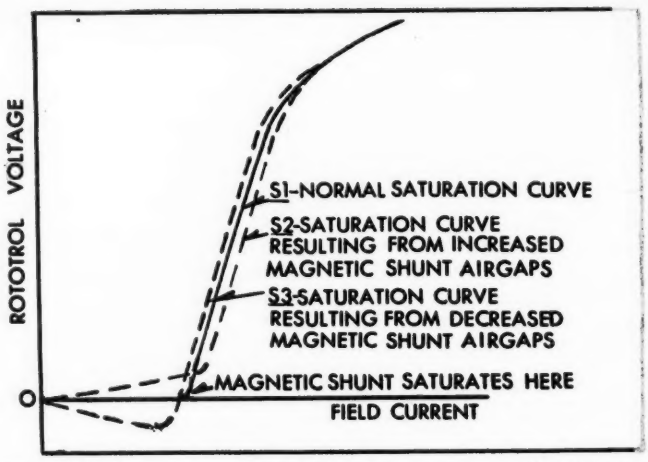

ROTOTROL VOLTAGE
S1-NORMAL SATURATION CURVE
S2-SATURATION CURVE RESULTING FROM INCREASED MAGNETIC SHUNT AIRGAPS
S3-SATURATION CURVE RESULTING FROM DECREASED MAGNETIC SHUNT AIRGAPS
MAGNETIC SHUNT SATURATES HERE
O
FIELD CURRENT

Fig. 5B. Saturation curve for current-limit Rototrol

Coils B, placed on the magnetic shunts are connected in series with Coils A on the main poles so the same field current passes through all coils.

The direction of the magnetic flux through the different air-gaps is indicated by arrows. The number of turns in the coils and the different air-gap dimensions are selected so that the total main pole flux will pass through air-gaps B, and the magnetic shunt and no flux will pass through air-gaps A and the armature as long as the magnetic shunt remains unsaturated. For this condition the Rototrol voltage, therefore, will be zero. With increasing field current the magnetic shunt becomes saturated and further current increase beyond this point produces a flux in the armature air-gaps. The unusual saturation curve obtained in this manner is shown in Fig. 5B.

For some applications it may be desirable to produce a slight voltage rise with increasing current even before the magnetic shunt is saturated. This can be obtained by a slight increase in air-gaps A which results in a saturation curve similar to S2. If air-gaps A are decreased the result will be a negative Rototrol voltage until the magnetic shunt is saturated as illustrated by saturation curve S3.

Current limit Rototrols are used principally on mine hoists, dynetric balancing machines, and reversing blooming mills where high inertia loads must be started or stopped in a minimum time without exceeding a safe current. In the dynetri balancing machine used to balanc rotating parts, a current limit Roto trol effectively limits the accelerat ing and decelerating torque trans mitted through a delicate couplin located between the motor and the mass to be balanced to the maximum safe value which can be transmitted through the coupling without damage.

The circuit used for the dynetric balancing machine is shown in Fig. 6. In operation the field rheostat on the motor and generator are usually preset for a motor speed depending on the object to be balanced. The switch is then operated to start the motor. In the first instant after closing the switch, Rototrol pattern field PF is excited cumulatively. Next the current field CF becomes excited cumulatively due to current starting to build-up in the Generator-Motor armature loop. In the meantime, the current in the slower generator fields is increasing but due to the output of the current limit Rototrol opposing the separate excitation of the generator fields, the generator voltage is limited to a value determined by the pattern field, current field, and the differential voltage field of the current limit Rototrol. As the drive motor accelerates the ampere turn value of the differential voltage field gradually increases until it exactly cancels the pattern field ampere turns.

On deceleration the switch is opened, the current in the generator-motor loop reverses, reversing the current field. The differential voltage field remains in the same direction. The combination of current field and voltage field causes the current limit Rototrol to sustain the field on the generator to regeneratively brake the load to a stop with a definite current limit.

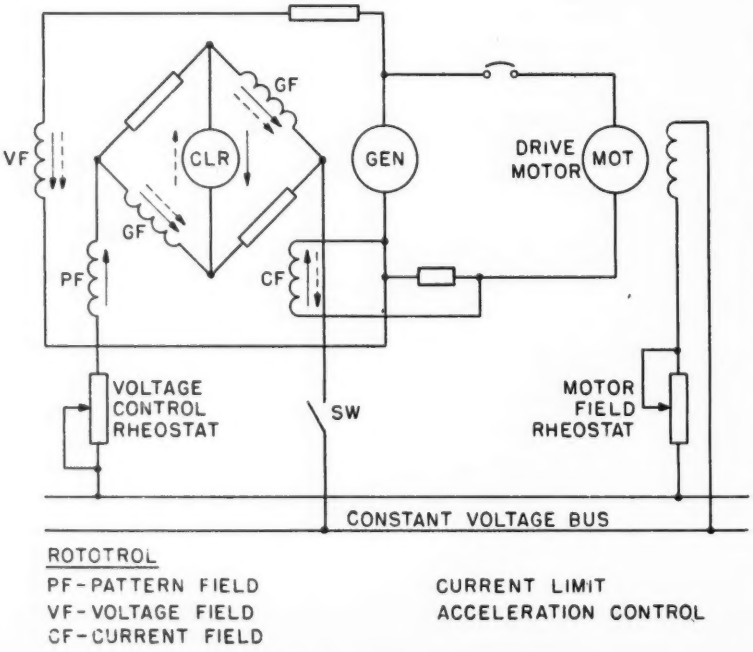


Fig. 6. Schematic of circuit for dynetric balancing machine

Editor's Note: This is the first part of a two part article on this subject by the author. The next part to be presented in the next issue will consider various applications of the Rototrol.

Reducing Boiler Sludge With a Silica Equilibrium

Part II. In this second part of his article, Dr. Welsh continues his discussion of the use of controlled amounts of silica in boiler water by citing a number of actual histories of cases where the system has been applied . . . In no boiler where the silicate feed has been used has there been increased development of silica or complex-silicate scale

By **J. N. WELSH** Director of Engineering Service, Hall Laboratories, Inc.

IN THE FIRST PART of this article in the March issue the effect of silica in boiler feedwater was described. As boiler pressures and temperatures increased and as boilers were operated at higher and higher ratings for extended periods of time, the fear of silica grew to vast proportions and much of the literature on boiler water treatment had to do with the removal of silica from boiler feedwater.

More recent studies, however, indicated that a controlled amount of silica in the feedwater, rather than being harmful, actually was beneficial. Thus, the procedure of adding silica to the boiler feedwater developed.

Now, in this second part, the actual results obtained from the addition of silica will be considered in detail. Results in actual use during the past six years have been astonishingly good. Sludge accumulation has practically stopped in boilers in which a dangerous condition existed previously. Operation of hot-process softeners and filters has been improved. Difficulties have been slight and have been largely confined to the increased rate of deposition infrequently observed in chemical pumps and lines of hot-process softeners when sodium silicate is added to the chemical tanks with lime and soda ash. In no boiler where the silicate feed has been instituted has there been increased development of silica or complex-silicate scale. In two only has there been increased deposition of silica on turbine blades; the boilers in these two operate at the highest pressures (800 psi and 1800 psi) at which silicate conditioning has been applied.

Table II. Treated-water and boiler-water analyses showing changes in silica and magnesium concentrations produced by the addition of sodium silicate along with lime and soda ash to a hot-process softener

		Before Silicate Feed			After Silicate Feed	
		1	2	3	4	5
		Raw Water ppm	Treated Water ppm	Boiler Water ppm	Treated Water ppm	Boiler Water ppm
Hydroxide	(OH)	0	2	88	0	86
Carbonate	(CO_3)	0	22		14	
Bicarbonate	(HCO_3)	270	0	0	20	0
Sulfate	(SO_4)	60	65	950	55	725
Chloride	(Cl)	27	26	285	28	245
Phosphate	(PO_4)			50		35
Silica	(SiO_3)	17	1	10	3	20
Calcium	(Ca)	84	5		4	
Magnesium	(Mg)	25	2		0.4	
Hardness	($CaCO_3$)	313	21		12	
Total solids				2460		2005

CORRECTION

Attention is directed to several errors in Part I of Mr. Welsh's article in the March issue. These are as follows:

Mr. Welsh's initials are J. N. Welsh, not J. W. as printed on page 76.

On page 77, column 1. Per Cent chart under Silica Equilibrium. The formula should be as follows:

$3\,Ca_3(PO_4)_2 \cdot Ca(OH)_2$

On page 126, line 2, the word equivalents, spelled "ents" instead of "ence."

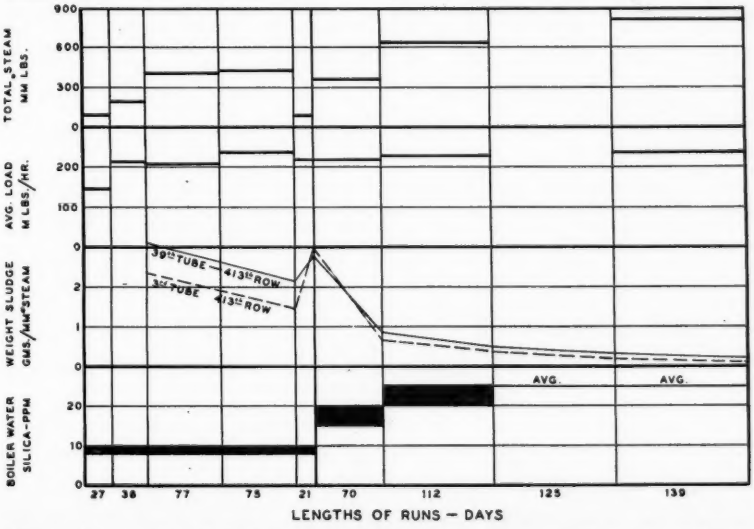


Fig. 3. Increase in boiler-water silica concentration reduces generating tube sludge in spite of increased operating periods and ratings

Data from the Field

The following case histories will be of interest.

CASE A

It is in this plant, operating boilers at 440 psi with feedwater containing approximately 50 per cent hot, lime-soda treated well water, that deposits having the composition indicated by Table I[1] used to form. The data in Table II are presented primarily to show what happens in the treated makeup and boiler water with and without the use of silicate in a hot-process softener when the raw water available is hard, high in bicarbonate and relatively high in silica, but with insufficient silica to take care of the magnesium.

At the time the "After Silicate Feed" samples were collected, silicate feed was approximately 21 ppm

[1] Table I appears in Part I in the March issue.

Table III. Analyses showing composition of raw Mississippi River water, silica removal produced by clarification and hot-process softening with dolomitic lime and soda ash, and relatively low silica concentration in boiler water

		1 Raw Water ppm	2 Softened and Filtered Water ppm	3 Boiler Water ppm
Hydroxide	(OH)	0	0	108
Carbonate	(CO_3)	0	32	
Bicarbonate	(HCO_3)	128	4	0
Sulfate	(SO_4)	78	83	690
Chloride	(Cl)	75	84	610
Phosphate	(PO_4)			10
Silica	(SiO_2)	8	3	14
Calcium	(Ca)	49		
Magnesium	(Mg)	11	Tr.	
Hardness	$(CaCO_3)$	168	14	
Suspended solids		High	8-10	
Total soilds				2424

of SiO_2 against the theoretical requirement of 24 ppm corresponding to complete precipitation of magnesium as serpentine. The possible need for slightly more silica is indicated by the relatively low boiler-water silica concentration of 20 ppm. Even so, improvement in magnesium removal from the treated water is substantial.

Case B

This plant operates 250,000 lb per hr. integral-furnace boilers at 650 psi. There is no condensate except the steam condensed in the deaerating heater. Makeup is Mississippi River water which is first clarified by coagulation with ferric sulfate and lime at a pH of 9.5-10.0, and is then treated in hot-process, lime-soda softeners.

When operation was started silica removal was deemed important and thus dolomitic lime was used with recirculation of sludge. Quite good removal was accomplished as is illustrated by Table III which shows 3 ppm of SiO_2 in the softened, filtered water and 14 ppm in the boiler water. Average removal of silica, and hardness as well, was probably even better, as plant results show silica concentrations as low as 0.8 ppm in the softened water with hardness as low as 6 ppm of calcium carbonate while silica values as low as 8 to 10 ppm were found in the boiler water.

In spite of the low cencentration of magnesium in the treated water, it was not long until the boilers were dangerously dirty with soft, adherent sludge deposits. The typical analysis of deposit from generating tubes given in Column 1 of Table IV shows the low silica and relatively high magnesium oxide characteristically resulting from too little silica in the boiler water.

Evidence was overwhelming that silica removal should be discontinued and the concentration of silica in the boiler water increased. This was accomplished by substituting high-calcium lime for dolomitic lime and adding 5 to 10 per cent well water, low in magnesium and containing about 50 ppm silica, to the clarified river water going to the hot-process softeners. Results were as expected. Heavy sludge deposits no longer accumulated anywhere in the boilers and the composition of what sludge was found changed materially. Column 2 of Table IV gives a representative analysis which is characterized by lower magnesium oxide and sufficient silica for combination with the magnesium oxide as serpentine.

Fig. 3[2] gives an excellent picture of reduction in sludge deposition. The data relate to one boiler and show how with uniform boiler-water phosphate concentration less and less smudge was found as boiler-water silica concentration increased, in spite of increased operating periods and ratings.

When it had been definitely established that the difficulty with sludge was being overcome, the boilers were acid washed. This revealed a problem which had not previously come to light. Quantities of acmite scale were loosened from the tubes. This scale resulted from attack on the steel as a result of evaporation of boiler water to high concentration underneath the heavy sludge; most certainly serious tube losses would soon have resulted if formation had not been discouraged by silica conditioning for prevention of sludge accumulation.

Table IV. Principal constituents of deposits formed in generating tubes of 650 psi, 250,000 lb per hr integral-furnace boilers show change from magnesium hydroxyphosphate to magnesium silicate in sludge after substitution of high calcium lime for dolomitic lime in the softener and the mixing of some high-silica well water with the clarified Mississippi River water used as makeup

	1 %	2 %
Calcium phosphate as hydroxypatite $3Ca_3(PO_4)_2Ca(OH)_2$	59	76
Magnesium hydroxyphosphate $Mg_3(PO_4)_2.Mg(OH)_2$	20	
Magnesium silicate as serpertine $3MgO.2SiO_2.2H_2O$		12
Iron and aluminum oxides R_2O_3	20	8

Case C

Sludge in a 300,000 lb per hr, 800-psi cross-drum boiler showed the familiar condition of insufficient silica for the magnesium. The makeup water prior to hot-process, lime-soda softening was deficient in silica for the magnesium, Table V, Column 1, and the boiler water was low in silica, Table VI, Column 1.

On the basis of these guideposts, water glass was introduced to the softener to increase silica concentration of the boiler water. Almost immediately the sludge content of the boiler water increased and phosphate consumption dropped to some extent. This gave evidence of magnesium going to the silicate rather than to the phosphate and of less sludge sticking to the evaporative surfaces.

Nine months later the consensus was that the use of the silicate had improved the internal condition of the boiler except in the upper-deck generating tubes. However, the high-pressure, non-condensing tur-

[2] Fig. 1 and 2 appeared in Part I in the March issue.

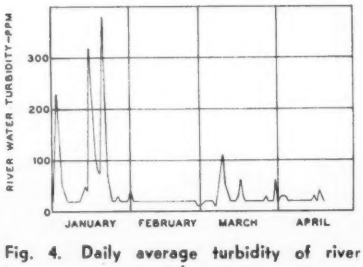


Fig. 4. Daily average turbidity of river water

Table V. Raw water analyses from four plants. Columns 1, 2 and 3 show unsatisfactory silica-magnesium relationships with pretreatment being hot-process, lime-soda. Relationship seems to be about right in Column 4 analysis but this water used with no treatment but internal phosphate conditioning produced excessive sludge deposits

		1 ppm	2 ppm	3 ppm	4 ppm
Bicarbonate	(HCO_3)	63	98	429	29
Sulfate	(SO_4)	49	25	103	28
Chloride	(Cl)	8	3	14	14
Silica	(SiO_2)	4	6	8	4
Calcium	(Ca)	36	26	100	14
Magnesium	(Mg)	5	8	22	2
Hardness	$(CaCO_3)$	111	98	340	41
Suspended solids			11		4-6

Table VI. Typical analyses of boiler water before and after introduction of water glass to hot-process softener supplying makeup water for 300,000 lb per hr, 800-psi, cross-drum boiler

		1 Before Silicate Feed ppm	2 After Silicate Feed ppm
Hydroxide	(OH)	95	79
Sulfate	(SO_4)	400	325
Chloride	(Cl)	61	40
Iodine demand	(Na_2SO_3)	26	44
Phosphate	(PO_4)	25	50
Silica	(SiO_2)	15	57
Total solids		1424	1256

bine was opened for routine inspection. It had shown no distress during operation but thin deposits containing over 90 per cent silica were found on the blades of the last four stages. Since the machine had previously operated for almost 17 yr without deposition and since it was felt that even with somewhat lower concentrations of silica in the boiler water, the harmless deposit might develop into a serious problem during operation over a longer period of time at the relatively high pressure involved, the use of water glass in the softener was discontinued.

Case D

Prior to 1944 this plant was in trouble with adherent sludge deposits and tube failures, particularly bridge-wall tubes, in the 650-psi, stoker-fired, Stirling-type boilers. When the problem was analyzed correctly the development of deposits was not hard to understand.

Makeup was about 50 per cent hot-process, lime-soda treated river water. The raw river water, Table V, Column 2, excluding suspended matter, was low in silica for the magnesium. Also sludge analyses showed silica to be too low for combination with magnesium as serpentine. [The analysis in Column 3 of Table VII shows 20 per cent magnesium oxide and 9.5 per cent silica whereas in serpentine the relationship in percentages of the two constituents is 1:1.]

Feeding of water glass to the softener was started early in 1944. Good control of the feed was not established immediately since variations in the amount of suspended material in the raw water, as indicated in Fig. 4, produced uncontrollable silica concentrations in the treated and boiler water. Furthermore, dissolution of suspended matter in the hot, alkaline treated water resulted in the introduction of aluminum to the boiler water and introduced the possibility of complex-silicate scale formation.

Change was made to filtered river water, whereupon silica control was no longer difficult and the sludge lost its adherent character. The representative analysis of Column 6, Table VII, shows the improved composition, silica and magnesium oxide being present in equal percentages. For almost three years deposits in the boilers and tubes losses practically disappeared. Then there was an interlude of about seven months when some further difficulty was experienced because of the necessity of using unfiltered river water in the softener. During this period some undertreatment with phosphate, low alkalinity because of excessive blowdown, and deposition of complex-silicate scale were contributing factors in the trouble.

Benefits derived from silicate conditioning were not confined to the boilers. Before the use of silicate, sludge had penetrated the softener filters badly, had accumulated in the filtering material, and seemed to be present in layers, between layers of filtering medium. After only two months of silicate feeding there was so little sludge in the filters after backwashing that it was impossible to get a sample thereof for analysis without including considerable anthracite. Also reports indicated that the filtering material was regrading during backwashing. These facts illustrate the non-cementing nature of magnesium silicate as compared to magnesium hydroxide.

Column 1 and 4 of Table VII give analyses of sludge from the sedimentation tank before and after silicate treatment. Columns 2 and 5 give analyses of filter sludge before and after. Changes in the relationship between silica and magnesium oxide are quite marked, there being almost enough silica in the later samples to take care of all of the magnesium oxide as serpentine.

Some figures on the consumption of water glass are of interest. During one month chosen at random approximately 28 ppm of chemical actually was used in the treatment of almost 37,000,000 gal of makeup water. Assuming precipitation of all magnesium in the makeup water as serpentine, and taking into consideration the water glass required to produce the silica concentration maintained in the boiler water for the amount of blowdown given the boilers, the calculated water glass consumption was the same figure of 28 ppm.

Case E

In certain instances the primary objective in using sodium silicate has been improvement of the operation of a hot-process softener. Consider a case where water having the composition shown in Table V, Column 3, is pretreated in equipment of this type for use in 160-psi, longitudinal-drum boilers. Softener capacity is 24,000 gph but one winter the load on the boilers was such that softener capacity was greatly exceeded. Average makeup water requirement throughout 24 hr was 31,000 gph with peaks of approximately 37,000 gph.

It was not surprising that the water leaving the sedimentation tank was loaded with suspended sludge and that the greatly overloaded filters were so ineffective that the water going to the boilers was considerably harder than the raw water. It was difficult or practically impossible to blow down the boilers sufficiently to limit total solids to a reasonable level, boiler-water alkalinity climbed unreasonably high, phosphate consumption was tremendous, severe carryover occurred, boiler operation was unsafe and plant production was endangered.

Immediate installation of additional available filters and certain other mechanical changes helped materially but the effluent from the sedimentation tank still contained a greatly excessive amount of suspended sludge and operation was still unsafe. On the basis that precipitation of magnesium as the silicate rather than as the hydroxide

(Continued on page 118)

Table VII. Principal constituents of hot-process sedimentation tank, filter and boiler sludge before and after silicate feed to the softener. Changes in magnesium-silica relationship after silicate feed are notable

		Before Silicate Feed			After Silicate Feed		
		1 Sed. Tank %	2 Filter %	3 Boiler %	4 Sed. Tank %	5 Filter %	6 Boiler %
Phosphorus pentoxide	(P_2O_5)			25			18
Silica	(SiO_2)	2	8	9	5	11	20
Iron & aluminum oxides	(R_2O_3)			13			8
Calcium oxide	(CaO)	48	40	28	46	33	25
Magnesium oxide	(MgO)	6	10	20	7	12	20
Ignition loss (including	CO_2)	43	40	5	40	40	8

Table VIII. Analyses of sludge formed in 450-psi boiler show differences in magnesium oxide-silica relationship. Feeding of silicate to boilers cured problem

		1 %	2 %
Phosphorus pentoxide	(P_2O_5)	25	22
Silica	(SiO_2)	8	13
Iron oxide	(Fe_2O_3)	10	14
Calcium oxide	(CaO)	33	22
Magnesium oxide	(MgO)	9	19
Ignition loss		12	8

A Stoker for Wood Refuse

This is an interesting account of rather trying experience with a chain belt conveyor. As the author explains, after it was installed it would not work; it gave no end of trouble and, in the end, had to be abandoned. Then a rubber belt was substituted and lo! it worked like a charm. Why? Let Mr. Gusler tell you in his own words

By DENARD L. GUSLER

THE STOKER described in this article was first developed at the Stanley Furniture Co., Stanleytown, Virginia. This article, therefore, is a continuation of the article Power Plant Improvement at Stanley Furniture Company, which appeared in the April 1948 issue of POWER GENERATION.

The original stoker design is shown in Fig. 1. A metal conveyor housing was centrally located about two feet from the bottom of a 30-ft wood bin. The conveyor was a chain belt riding on a metal partition and driven by four, 10-in. sprockets which, in turn, were driven by a Reeves variable speed drive. Idlers at the back of the conveyor made it possible to adjust the belt tension. The conveyor emptied into a hopper which connected to the suction of three fans. These fans fed the fuel to dust collectors and thence by gravity into the furnaces. The amount of fuel being fed to each boiler was controlled by distribution dampers.

When the conveyor was first installed it was intended that the first few tons of sawdust would fill the bottom of the wood bin and gradually form sloping sides that would converge on the conveyor belt. Later this problem was given further consideration and it was decided that a steel hopper would be more satisfactory. A sectional steel hopper was then built and installed as shown in Fig. 2. This hopper was sloped at an angle at 45 deg. It was installed on steel columns set on the floor and tied together with tie rods shown by broken lines in Fig. 2. The construction was such that the hopper was independent of the wood bin walls in order that a Syntron vibrator could be mounted under the hopper. Thus, the vibration of the hopper, when the vibrator was in service, would not be transmitted directly to the walls of the bin. Another advantage of the steel hopper was that it made the conveyor more accessible. Also there would not be a mass of dead fuel in the wood bin. All that went in would eventually come out.

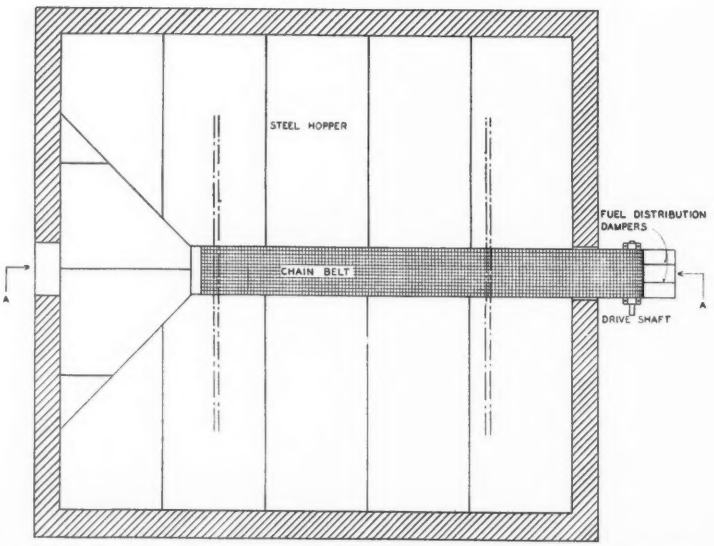


Fig. 2. Plan of the sectional steel hopper. Tie rods indicated by broken lines

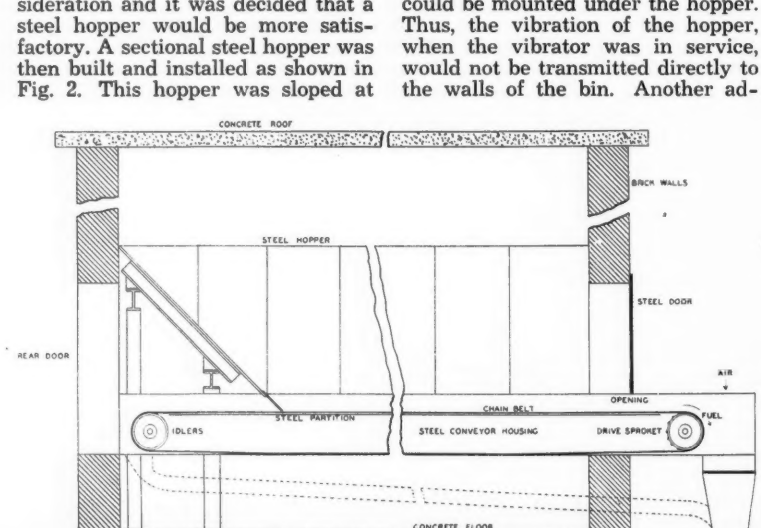


Fig. 1. Original design of fuel bin and chain belt conveyor

The Chain Belt Did Not Work

The chain belt conveyor did not work for several reasons. In the first place it was found that the dust collector imposed a positive pressure on the wood bin. This pressure caused a seepage of sawdust at every point not actually sealed completely against air. The velocity of the fuel leaving the dust collector was such that a serious packing resulted. The fuel, instead of spiralling gently downward from the collector discharge, was driven down with terrific force. In theory, the mesh chain was workable. It was made up of steel alloy rectangular links about ½ in. square and ½ in. deep joined together by a small rod. The weight of the fuel forced miscellaneous particles into the mesh openings thus creating a moving mass traveling towards the conveyor opening. However, there was a serious drawback. The conveyor opening was 6 in. high and 22 in. wide. Thus only a small amount of fuel could leave the conveyor at any time. The remainder

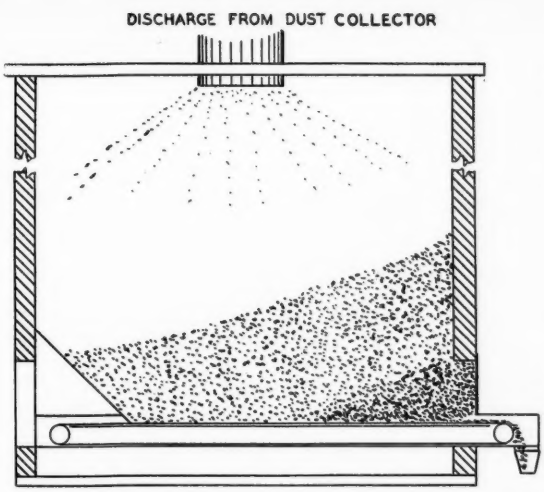


Fig. 3. The chain belt in action. Note how the fuel packs at the outlet

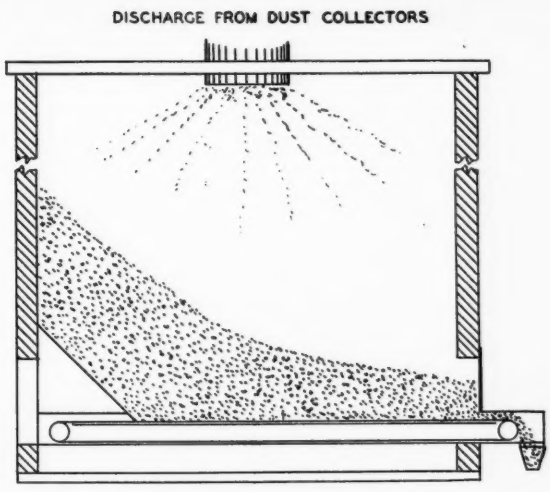


Fig. 4. With the rubber belt everything is hunkey dory. No packing at any point and the fuel flows easily

of the fuel piled up against the wall as shown in Fig. 3. This fuel continued to pack tighter and tighter until it tended to jam the conveyor chain. The chain was then subjected to a terrific friction opposite in direction to the motion imposed by the drive sprockets. When this friction reached certain magnitudes something had to give and it was usually the chain. It would stretch and distort until disengaged from the drive cogs.

I believe that almost every conceivable effort was made to make the chain conveyor work, not only by the author but by others as well. It was found that the fan suction tended to pull hog refuse, in the form of long slivers of wood, through the chain openings. These slivers would then cross up and be trapped inside the chain. They were carried back to the rear of the conveyor and revolved around the idlers until evicted by the same random motion that trapped them. All types of baffling was installed to prevent this action but none were successful. To overcome the friction in the wood bin additional drive cogs were added to create the effect of a drum drive but this too was unsuccessful.

Why the Chain Would Not Work

Before leaving the chain drive I would like to say that its failure was due primarily to fragile mechanical construction and to hog refuse. The fuel mixture consisted of sander dust, sawdust, shavings, and hog refuse. The friction the hog refuse imposed on the chain by interlocking in its openings, the manner in which it obstructed the exit from the wood bin, and the manner in which it continually clogged the conveyor operation, all contributed to the chain failure. I believe the chain belt would be an excellent device when handling shavings or sawdust. Shavings are light and springy and the chain openings would be just the thing to force them through a small opening. In fact I know of one plant that uses this chain. But their conveyor is only 8 ft long and the bin is just a few feet high.

One plant experimented with a woven wire belt. This belt was woven of wire in the same manner that a fence is woven. It was extremely stout and had small openings through which hog refuse could not enter. It was expected that the friction occasioned by jamming a fuel mass through the small exit would not be in evidence because the mesh, being relatively smooth, would slide under the fuel. Again a spectacular failure. The driving force necessary to move this type belt under the fuel mass was such that it was impossible for a ten inch drum drive to move it without slipping. An idler pulley was built and installed that caused the woven belt to wrap around a greater area of the drive pulley but this too was unsuccessful. The belt had to be tightened until it stretched out of proportion and then, being metal, it had no spring to it so it assumed and maintained the stretched condition and became slack again. The organization that tried the wire finally went back to the chain, temporarily, as the lesser evil.

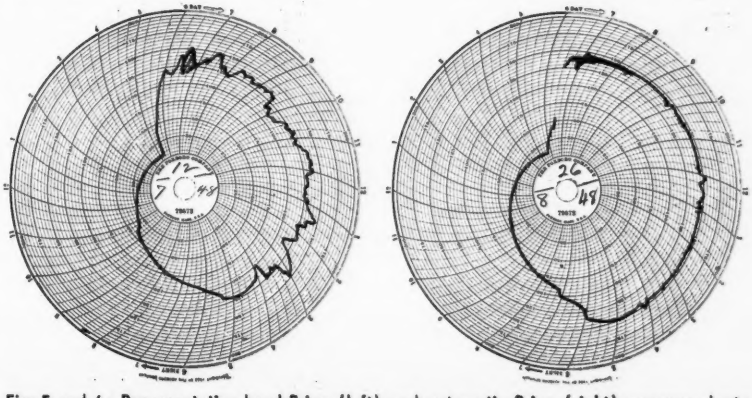
In the meantime, at the Stanley Furniture Company, we were still having chain trouble. We had worked with the first chain until it was a mass of twisted metal and then installed a second chain exactly like the first. It soon became apparent that it was going bad.

Rubber Belt—An Ace in the hole

We had on hand a rubber belt which we called the last resort. It was an excellent conveyor belt, 20 in. wide and ⅜ in. thick, built by the Goodyear Rubber Co. It was about ⅔ woven cord and rubber with a ⅛ in. layer of pure rubber on the outer surface. From information garnered here and there rubber belts had never been too successful for the service we intended using it for. Never-the-less we had no choice. The second chain was about worn out and we had to have something. Accordingly we made preparations to use the rubber belt.

By use of 10-in. pipe and other materials we made two drum pulleys. One for the drive and one

(Continued on page 122)



Figs.5 and 6. Representative hand-firing (left) and automatic firing (right) pressure charts

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Don't Forget the Lithium-Hydrogen Reaction

In the Cockcroft-Walton, experiment, in which lithium is bombarded by hydrogen nuclei twice as much energy is released as in uranium fission. Long neglected, this reaction suitably combined with uranium fission may be capable of producing the super-atomic bomb the Sunday feature writers like to imagine. While it is only a possibility, it should not be discounted in our long range plans for national defense

By **ANDREW W. KRAMER,** Editor, Power Generation

WHILE the atomic armament race between the western democracies on the one hand and the Soviet Union on the other continues its accelerating and relentless course, the problem of defense against atomic weapons grows in the minds of those who regard the atomic bomb as, just another weapon. At the moment, in Washington, there is impassioned agitation for the establishment of an extended radar warning screen around the entire continental United States and Canada. Whatever merits the creation of such a warning screen may have, protectively, technically or psychologically, it may be more to the ultimate benefit of the human race if we assumed at the start that there is no defense against the atomic bomb and utilized our energies in other directions. It was the French military's confidence in the protective qualities of the Maginot Line that proved its swift and tragic downfall when war came. Similarly, it would be unwise for us as a nation, or a continent, to bask in serene confidence behind the false security of an invisible radar screen.

Remember, In Great Britain, by 1939, the Air Ministry had already constructed the so-called coastal radar chain which enabled it to detect aircraft approaching over the sea at distances up to about 60 miles. While this was effective, it did not prevent Nazi bombers from destroying many English cities, and when, at the end of the war the V-2 came, it was totally unable to prevent a single V-2 from coming through. When the time came, British and American forces in England were able to watch the Nazis' V-2's taking off from continental European areas in the radar 'scopes of the giant microwave early-warning net on the British coast, but they could do nothing about it. They could see the trace of the V-2 slow up, arch over and watch it coming toward England—could watch its descent and know when, and approximately where, it was going to strike. But they were totally helpless in being able to do anything to interfere with its deadly descent. It is very difficult to do anything to a missile traveling at a rate of a mile per *second.*

V-2's Versus V-1's

V-1's, the robot planes which the Nazis sent over to England were shot down in ever-increasing numberes as time went on, but there was a vast difference between the V-1 robot planes and the V-2's. The V-1's were automatically-controlled, fast flying model airplanes carrying about a ton of high explosive. They had wings and used the atmosphere as a means of support, just like any other airplane. The V-2, on the other hand was an entirely new weapon, it was a true rocket. It did not depend upon air either for its support or for the combustion in its powerful jet engine. It was propelled and lifted entirely by the reaction of the exhaust gases of a furiously burning mixture of oxygen and alcohol. It operated best at altitudes above 60 or 70 miles where there is practically no atmosphere.

In any future atomic war, and the next war will be an atomic war, the atomic bombs will be carried by missiles of the V-2 type. As is well-known, our own research in the direction of development of rockets has been carried on continuously, at White Sands, New Mexico, ever since the war ended. Only within the past few weeks the Army Ordnance succeeded in firing a 2-stage rocket to a height of some 250 miles! This was more than twice the best height (114 miles) reached by the V-2 and well outside the earth's gaseous atmosphere.

True, rockets are a long way from perfection and if an atomic war broke tomorrow we would attempt to deliver atomic bombs not by rockets, but by means of conventional aircraft. It is quite evident, however, that war will not come tomorrow. But the longer the next war is off, the more time both sides will have to develop and perfect missiles of the rocket variety, and the more disastrous it will be for all concerned.

The question of the atomic bomb cannot be considered alone. The atomic bomb must be considered in relation to rocket design, to atomic power developments and to technical development in general. As has been recounted in other articles in these pages, the Atomic Energy Commission is engaged in large scale projects to bring about the early development of atomic power plants, both for stationary and mobile use. And, as indicated in the article in the February issue on the use of atomic energy for the propulsion of aircraft and ships, the use of atomic power will not only make our aerial weapons and warships more deadly —it will vastly increase their range of action. One of the limiting factors in the development of long range rockets at the present time is the inability to concentrate enough fuel into the missiles. With the successful application of atomic power to rocket propulsion, this limitation will be removed and rockets can, then, be sent anywhere on the face of this earth.

The 2-stage rocket which attained the extreme height of 250 miles at White Sands a few weeks ago also attained a speed of some 5000 miles an hour (1.39 miles per second), this, by the use of conventional fuels. Suppose that such a rocket is developed using atomic energy. It may be quite possible under such circumstances to give the rocket a speed of 5 miles per second. This speed of 5 miles per second is critical—a body moving just outside the earth's atmosphere at that speed will never fall to earth. It will become a small satelite and continue to travel around the earth for millions of years unless otherwise disturbed. If, by means of radio or clockwork such a rocket could be restarted—pushed down a bit, it would, of course, be brought to earth again.

Rockets With Infinite Range

It is evident, then, if, by means of atomic energy we can increase the speed of rockets from the present value of a little over a mile per second to five miles per second, we will not just increase the present range in proportion to the speeds but will give them *infinite* range.

Do these things seem strange and far fetched? Just remember that only a little over a decade ago, the atomic bomb was equally far fetched and the V-2 rocket only a little less so. We understand many basic facts that were completely unknown ten years ago and there is no telling what the next ten years will bring. During the last war, no city anywhere in Europe was safe from aerial attack. In the next war, no city in the world will be safe from such attack. Radar warning screens may help to warn of the approach of aerial attacks and counter rockets may possibly be designed, but a certain percentage of missiles will get through and if these carry atomic explosives, our prospects, at best, are not very pleasant.

One may try to look at the picture from a statistical standpoint; that out of a large number fired, only a certain percentage would get through. That is usually the way in which military weapons have been regarded but there is a vital difference between the atomic bomb and previous weapons. One atomic bomb is capable of destroying a city. This statement may be challenged on the basis of the bombs used in Japan or in the Bikini tests but the atomic bombs of the future probably will bear as little resemblance to these as the ten ton blockbusters used on the German cities at the end of the war did to the 500 lb bombs used in the early months of the war. Already, as reported in the Fifth Semiannual Report of the AEC, there has been a gain in efficiency in the release of atomic energy in newer bombs. In the three atomic weapons exploded in April and May of last year at Eniwetok Proving Ground accurate measurement indicated a substantial gain in energy release.

Outside of this fact, disclosed by the AEC, little is known regarding these later atomic weapons. Presumably, they were of the U-235 or plutonium variety, similar in principle to those used previously, but more efficient because of further refinement. It is barely possible however, that at least one of them was of a different variety.

Thus far, all the effort has been expended in the development of the plutonium or U-235 type bomb. This bomb is based on the principle of uranium fission by neutron capture. Scientists, however, have long been intrigued by another possibility—the possibility of releasing nuclear energy from light element reactions, that is, from reactions of elements toward the hydrogen end of the periodic table.

This possibility has been considered in previous articles in these pages[1] but it is so important that it is worth while to direct attention to it again, for two reasons; first because the materials involved are plentiful and cheap and secondly, because the energy release per unit of weight is greater than from uranium fission.

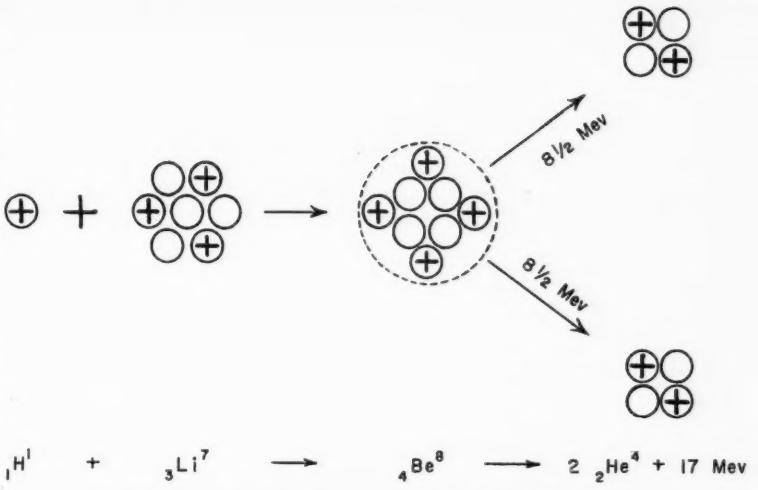


Fig. 2 This is what actually happens in the Cockcroft-Walton experiment

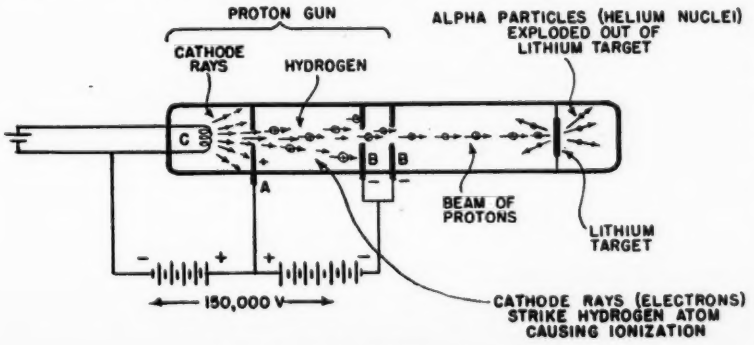


Fig. 1 The Cockcroft-Walton experiment

The Cockcroft-Walton Experiment

Of particular importance among

[1] See Eee Equals Em See Squared. Power Plant Engineering, Feb., 1949, p. 80.

possible light element reactions is the Cockcroft-Walton experiment involving lithium and hydrogen. This is capable of producing twice as much energy per pound of material as the detonation of uranium or plutonium.

The Cockcroft-Walton experiment goes back quite a long way—long before uranium fission. This experiment made by Cockcroft and Walton at Cambridge University in the Cavendish Laboratory in 1932 was the first effort in which transmutation was achieved by the use of particles that were accelerated artificially. Previous to that Rutherford had shown as early as 1919 that nitrogen could be transmuted into oxygen,[1] but he used the alpha particles from radium to effect this transmutation. Cockcroft and Walton bombarded lithium with hydrogen nuclei (protons) accelerated by electric potentials.

The apparatus which these investigators used is illustrated in Fig. 1. It consists of a proton gun comprising a heated cathode, C, and accelerating electrodes A and B. Electrons emitted by the hot cathode are accelerated by the positive potential applied to anode A. Passing through the aperture in A, into the space beyond which is filled with hydrogen gas at low pressure, the electrons ionize some of the hydrogen atoms. The ions being positively charged are accelerated by the cathodes B-B, these being at a potential of 150,000 v, negative with respect to A. The high negative potential on B-B also repels the electrons back to A. The fast-moving protons, however, pass through the apertures in the two cathodes and form a proton beam which impinges on the lithium target at the end of the tube. Here, the protons knock alpha particles (helium nuclei) out of the lithium atoms. The nuclear reaction can be expressed as follows:

$$ {}_1H^1 + {}_3Li^7 \rightarrow {}_2He^4 + {}_2He^4 \qquad (1) $$

This equation expresses the ultimate effect. Actually, what happens is shown in Fig. 2. This diagram shows a proton being added to a lithium nucleus. The latter, it will be seen, consists of 3 protons and 4 neutrons giving the nucleus as a whole an atomic weight of 7. The 3 protons, of course, have positive charges and normally would repel any other positive charged particle that tried to aproach it. The oncoming proton, however, is traveling at such a high velocity that it succeeds in piercing the powerful barrier of electric force surrounding the nucleus, and thus, for an appreciable moment becomes part of the new nucleus. This new nucleus is a beryllium nucleus since it has atomic number 4. This isotope of beryllium, however, cannot exist; it is not found in nature. Thus, when it is produced artificially, it is extremely unstable and in, say, a tenth or a hundred millionth of a second, it explodes violently, splitting into two equal halves—two helium nuclei. The explosion is one of extreme violence because the loss of mass involved in the reaction is converted into energy in accordance with the Einstein law.

Nuclear Bookkeeping

The actual quantities involved are of interest, so let us examine the bookkeeping. First, consider the atomic weights of the three nuclei that take part in the process. These are as follows:

Element	Symbol	Atomic Weight
Hydrogen	$_1H^1$	1.00812
Helium	$_2He^4$	4.00389
Lithium	$_3Li^7$	7.01804

Substituting these mass values in equation (1), we have

$$ 1.00812 + 7.01804 \rightarrow 4.00389 + 4.00389 $$

Carrying out the addition, we have

$$ 8.02616 \rightarrow 8.00778 $$

Note, that the two sides of this expression do not satisfy each other. The sum of the atomic weights of the two helium nuclei is less than the sum of the weights of the proton and the lithium nucleus. The difference is:

$_1H^1 + {}_3Li^7$	8.02616
$_2He^4 + {}_2He^4$	−8.00778
Difference	0.01838 mass units

This difference of 0.01838 mass units is the amount of mass which disappears and which is, thus, converted into energy in accordance with the Einstein equation, $E = MC^2$.

Numerically, the 0.01838 mass unit loss seems small indeed but it is large in terms of energy because of the terms of the Einstein equation which involves C^2, that is the square of the velocity of light. According to the Einstein law, 1 mass unit is equivalent to 931 million electron volts (Mev). Therefore 1 Mev is equal to 0.00107 mass unit. In the reaction under consideration, therefore, where 0.01838 mass unit is converted into energy, the amount of energy released is

$$ \frac{0.01838}{0.00107} = 17.1 \text{ Mev} $$

In other words, when lithium is bombarded with high-speed protons in this manner, the resulting nucleus splits into two helium nuclei with an energy release of 17 million electron volts.

For absolute accuracy our bookkeeping is subject to a slight correction. In the beginning, a potential of 150,000 v was used in accelerating the protons. The energy required to maintain this electric potential must of course be subtracted from the total amount of energy obtained in our calculations, but it is so small that for all practical purposes it can be neglected. The 150,000 ev represents only 0.0002 mass unit.

The Cockcroft-Walton experiment, therefore, releases 17 Mev of energy with an expenditure of less than 1/100 of that energy. The experiment is of great importance because it was not only the first experiment whereby transmutation of elements was achieved by artificially accelerated particles but it was the first known instance in which the atom was split. It proved the validity of the Einstein equation, and indicated that there were vast stores of energy in the nuclei of atoms that could be released by man-made apparatus. It pointed the way to the amazing and far reaching developments of the past 10 years.

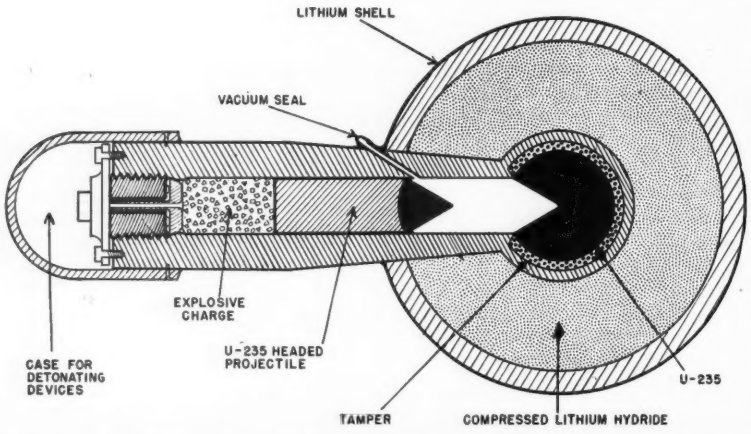


Fig. 3. Can this be made to work? It attempts to show how the lithium-hydrogen reaction might be used in a super-atomic bomb, using the uranium fission reaction as a primer

(Continued on page 126)

Air-view of General Electric's mammoth new turbine building nearing completion at Schenectady, N. Y. The 20-acre plant (center) will be capable of producing turbine-generators ranging from 20,000 kw to 200,000 kw. Movement of heavy machinery into the $30,000,000 building was begun recently. As soon as each machine tool is installed, production of component turbine parts gets underway

The World's Largest Turbine Factory

IN THE accompanying photograph is shown an air view of General Electric's mammoth new turbine building nearing completion at Schenectady, New York. This plant will be the largest turbine manufacturing plant in the world. It will produce turbine generators ranging in size from 20,000 kw to 200,000 kw. Erected at a cost of 30 million dollars the new plant covers 20 acres of land and will have more than a million square feet of floor space. The building is 600 ft wide and 1290 ft long, and contains a three-story forty foot wide service bay running the entire length of the building. As shown in the foreground of the photograph a four-story air conditioned office building having 71,000 sq ft of floor space will house the engineering, drafting and other activities. The complete plant will employ approximately 5000 persons.

When in full operation the plant will be capable of producing each month a quantity of turbines which could supply power and light for a city of 1 million inhabitants.

Construction of the building was a major engineering feat. One of the big problems was the design and installation of a foundation which would support the heavy loads imposed by the building structure and the cranes, some of which weigh 400 tons fully loaded. It was also necessary to limit to an absolute minimum the differential settlement of large machine tool foundations as well as the test floor area. The soil at the site of the building is made up of sand, silts and clay deposited over the years by the Mohawk River.

A total of 4700 H-beam piles were driven into the ground to provide a suitable support for the heavy building columns and the reinforced concrete mat for the heavy machine tool section and the test area.

One of the design requirements was that future relocations of large machine tools could be accomplished with a minimum of disruption. Normally, moving heavy machine tools is a major project as many require piled foundations which must be specially constructed at each location. To provide greater flexibility an unusual plan was evolved in the design of this new factory.

At a depth 7 ft below the regular floor a 16 in. reinforced concrete mat was constructed over approximately 2 acres of steel piles on 8 foot centers. This mat forms a stable base for most of the heavy machine tool foundations and will provide a piled base for future installations. The pit above the mat was filled with very fine crushed stone topped by a 10-in. reinforced concrete floor slab, this in turn was covered with two inch wood blocks which formed the operating floor.

Above ground there are 14,800 tons of structural steel with all field connections made by welding. The sides of the building are of concrete for the first 5 ft up to the window sash, the remainder is insulated metal siding protected with aluminum paint. The exterior of the office building is made of stainless steel panel.

The most modern type of lighting is used; fluorescent with a combination of mercury and incandescent. A total of 10,700 fixtures are installed, and the lighting load alone will require approximately 4000 kw of electrical energy. The machine tool connected load will be approximately 20,000 kw.

The building is advantageously located near the Schenectady Works power plant and the Mohawk River, permitting relatively short runs for the tremendous quantities of steam and water required. The steam will be used to drive the turbines on test and to heat the building and the water to condense the exhaust steam.

The steam exhaust mains in the turbine test area are located in trenches below the floor level and connected to condensers located in wells below the floor. It is estimated that the circulating water requirements for condensing the steam when all test stands are operating will be two and one-half times the normal water requirement of the entire city of Schenectady with its population of approximately 100,000.

A great deal of new and advanced equipment will be installed in addition to that moved from the present turbine plant. The factory will have a wide variety of machine tools ranging from the smallest fence grinder to a boring mill forty feet in diameter which can machine parts weighing up to 200 tons.

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

Metallizing Reduces Maintenance Costs in The Power Plant

By JOHN E. WAKEFIELD

THE EQUIPMENT used in steam power plants is designed and built for long life and dependability, but the time eventually comes when major repairs are needed. Packing journals and bearing surfaces become scored and worn beyond the point where they can be "trued up" or otherwise adjusted. Replacement of such machinery is expensive in more ways than one. The cost of new parts is necessarily high, and frequently delays in obtaining them are even more expensive. There can be no doubt that outage of equipment is one of the major problems which the operating engineer must face.

That is where metallizing comes into the picture. A metallizing gun is essentially a "putting-on" tool. With it, stainless steels, carbon steels, bronzes and other metals can be put back onto the worn surfaces of turbine shafts, pump parts, crankshafts and the like. Thus, vital equipment can be restored to useful life much faster and at a fraction of the cost of replacement.

The Process

A metallizing gun is a simple device in itself, a combination of an oxy-acetylene torch and an air gun. An air activated turbine and gear train feed metal, in wire form, into the head of the gun. Figure 1 illustrates the business end of a modern unit. As the wire emerges from the nozzle, it comes in contact with the oxy-acetylene flame, which promptly melts it. Then, hot gases and compressed air shear off the molten metal and drive it onto the work in the form of globules or spheroids. The particles are still molten when they land, and, due to that fact and their high velocity, flatten out and almost splatter over the surface. So much for the spray operation itself.

Far more important in the success of metallizing work is the preparation of the surfaces to receive the sprayed metal. First, they must be absolutely clean. In that respect, metallizing is no different from soldering, brazing, plating, welding and other processes for the joining of metals, or the addition of them.

Unlike these other processes, however, a surface to receive sprayed metal must be rough; not just irregular in the ordinary sense; full of hooks and tears into which the sprayed particles can key themselves physically.

Even this important consideration is not as complicated as might appear at first glance. Most methods of preparation recommended today accomplish both cleaning and roughening at the same time. A tearing thread cut, for example, exposes clean metal and at the same time leaves innumerable hooks for the sprayed particles. The newest method of preparation for continuous cylindrical surfaces is most promising. A few months ago, it was found that an alloy high in molybdenum could be sprayed with an ordinary metallizing gun and would bond itself firmly to smooth, even highly polished surfaces. Such surfaces have to be absolutely clean, of course.

The self-bonding material is of great value as an undercoat for other sprayed metals. When it is used, preparation consists of a light fast roughing cut, more to clean than anything else, and the application of 0.0015 in. to 0.002 in. of the undercoat. From that point, the worn packing or bearing surface can be built up to the desired size with any common metal. Incidentally, modern metallizing guns spray more than 30 different kinds of metal efficiently and rapidly.

There's no need to go further into

Engineers who have not been in a position to familiarize themselves with the advantages of metallizing in maintenance work little realize how valuable this process can be or how much work it can save. While it is not a panacea for all power plant troubles, it is extremely useful in the repair and maintenance of many worn parts and every operating engineer will find it to his advantage to learn all he can about this relatively simple process. In this short article, Mr. Wakefield, who, by the way has had many years experience in this work, outlines the principles of metallizing and describes its application to a number of different kinds of repair. Realizing, however, that it is impossible in a short article to cover all aspects of the subject, he anticipates many questions on the part of readers and has offered to answer any questions that anybody may have after reading the article, to the best of his ability. So if you are in doubt as to the efficacy of the metallizing process to your specific problem, do not hesitate to write. We will forward your questions to Mr. Wakefield

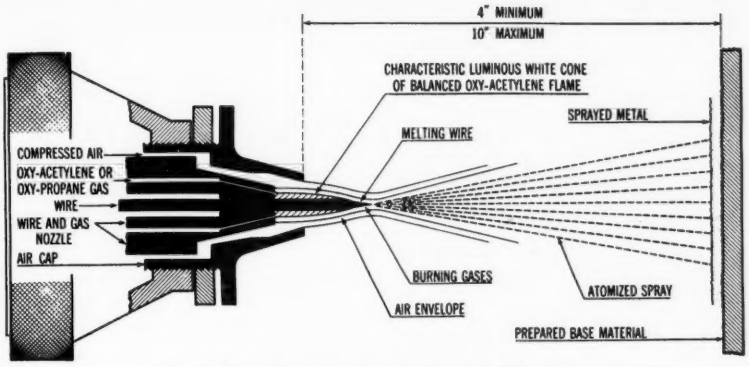


Fig. 1. The business end of a modern metallizing gun

the techniques of spraying and preparation at this point. Much valuable information is available in the handbooks published by the manufacturers of metallizing equipment. The main question here is, what will metallizing do in the maintenance of steam power plant equipment? Often, a knowledge of what a process won't do gives a better picture of its real value, so let's start with the limitations of the process.

Limitations

IMPACT

Sprayed metals will not stand direct impact. Therefore, they should never be used on parts such as the valve seats of internal combustion engines, or on cam surfaces. Fortunately, there are few parts other than these two types which have to stand such action.

ELONGATION

Sprayed metals will not stand much elongation. Hence, they should never be applied to surfaces on which balls or rollers operate directly. For example, a metallized shaft operating directly in contact with rollers failed in a matter of three days. Remetallized and placed in straight bronze bearings, the shaft has been running smoothly for more than seven years.

TENSILE STRESS

The tensile strength of sprayed metals is somewhat reduced, the highest being about 40,000 psi for high chrome, high carbon stainless type steel. Therefore, it cannot be expected to stand up on threads or gear teeth.

Those are the three types of applications for which metallizing should not be used. However, none of these conditions exists to anything like the same extent on shafts, packing or bearing surfaces. So, with these limitations in mind, let's see what metallizing will do. Probably the best way to demonstrate its value is to discuss some of the actual work done in steam power plants over the last 18 years.

PRACTICAL ENGINEER SECTION

Applications

TURBINE SHAFTS

One of metallizing's most successful applications is on steam turbine shafts, where packing sections have been restored. Figure 2 shows the sections of an 11 in. Westinghouse shaft already prepared for metallizing. This was a particularly interesting job, because, through the use of a portable lathe, the job was prepared, sprayed and finished without pulling the shaft, thus saving considerable time and money. By means of the portable lathe, a cleaning cut was taken over the scored surfaces, cleaning them and reducing the diameter about 0.080 in. Then, a 0.045 in. wide, square-nosed tool was used and a series of straight grooves cut in the clean surface. Depth of the grooves was about 0.025 in. and they were spaced to approximate a 14 thread feed. In work done in the machine shop, such a thread feed should be used. In this case, the proper feed could not be obtained.

After grooving, a special knurling tool was run over the surfaces several times with comparatively light pressure. Consisting of several saw-like blades with teeth set staggered, this special tool roughened the lands between grooves and rolled their edges slightly, producing dovetails in each groove. This work was done before the discovery

Fig. 3. Right: The same shaft as in Fig. 2, after the job has been completed. The built-up surfaces have been ground and the shaft is ready to go back into service

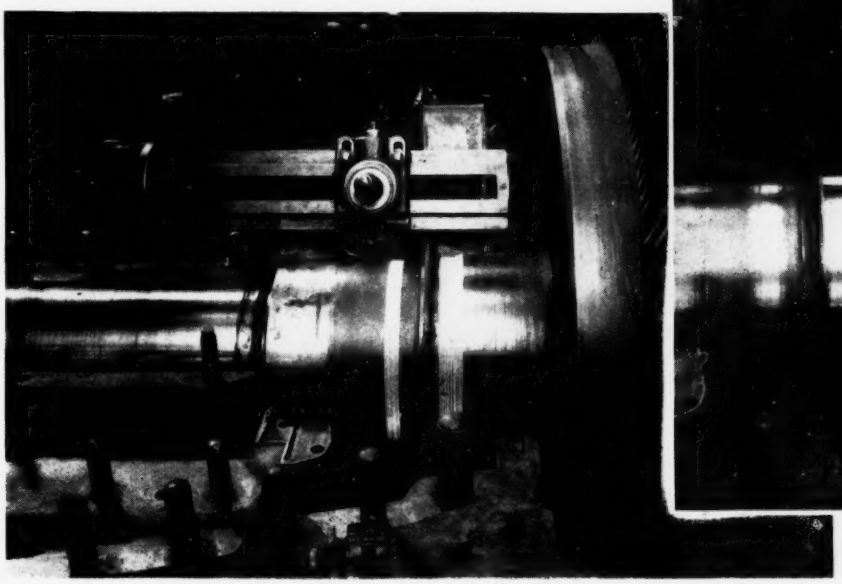


Fig. 2. Left: Two sections of an 11-in. turbine shaft ready for metallizing

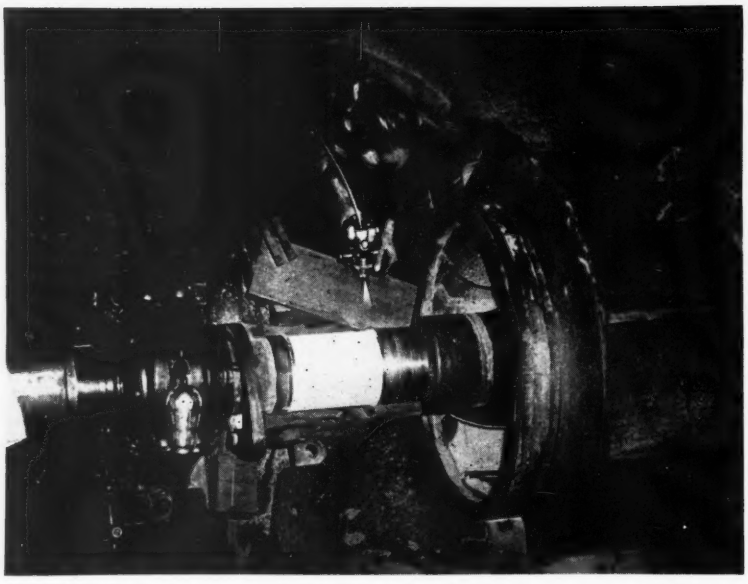


Fig. 4. Metallizing the bronze packing sleeves of a large circulating water pump with bronze

of the new self-bonding undercoat. Had it been available, the original cleaning cut would have been sufficient.

Surfaces were metallized with high chrome, high carbon stainless steel, which was selected because it resists not only wear but mild corrosive elements as well. First few passes across the surface were performed at an angle of approximately 45 deg, in order to fill the grooves and prevent bridging over from dovetail to dovetail. For the rest of the build-up, the gun was mounted in the tool post at 90 deg. About 0.025 in. was allowed on the radius for finish, as the sprayed coating is very uniform.

Finishing was done with a small portable grinder attached to the tool post mounting. Figure 3 shows the surfaces finished and the shaft ready to go back into service. Estimated cost of the entire operation was just under $100.00.

Pump Packing Sleeves

Similar work has been done many times on pump packing sleeves. Figure 4 illustrates the metallizing of bronze pump packing sleeves with bronze, for a large circulating pump. In this case, a lathe compound was mounted on the pump casing and used for preparation and finishing. Metallizing was done with a Tobin type bronze. Preparation was the same as for the turbine shaft. Incidentally, the self-bonding undercoat could not have been used in this instance as it does not bond to copper or its alloys.

Report of this pump job indicates that about 15 lb of bronze was needed on the one sleeve shown. Total cost of the work was estimated at less than $75.00.

At an eastern steam power plant, similar bronze sleeves were metallized, but this time with stainless steel directly over the bronze. Four in. in diameter by about 8 in. long on the worn area, they had been removed so that the work could be done in the machine shop. A new bronze sleeve was worth $44.00 at the time and the plant had also obtained prices for stainless steel sleeves at $169.00 each. These were the prices in effect in 1939 when the metallizing work was first undertaken.

Preparation, spraying and finishing amounted to only $7.94 per sleeve, even including the cost of the stainless steel wire. This particular job illustrates one of the great advantages of metallizing, the fact that better, harder, more wear resistant metals can often be applied over softer inferior ones. In fact, when last heard from, the stainless sprayed sleeves had already been in operation more than 3 times as long as the original bronze. Furthermore, the original packing was still in place.

Impeller Hubs

Figure 5 illustrates a group of parts which have been reclaimed by metallizing. Significant to the steam plant engineer is the impeller hub. Wear rings usually have sufficient metal across the wearing face to permit reboring for several reworkings of the pump. Standard practice is to reface the clearance surface of the ring by truing carefully in a lathe until a proper surface is restored. This, of course, leaves an undersize impeller hub, but it can be built oversize very easily with metallizing. From there it is no problem to refinish to the desired new size to function properly with the refaced ring. Figure 5 shows two impellers, one sprayed with bronze, the other waiting to be sprayed. Recently a new aluminum iron bronze has been introduced which has excellent characteristics for such work. It is hard, corrosion resistant and tough far beyond any previous metallizing bronze.

Figure 5 is interesting in another way, in that it shows various other practical metallizing applications. Motor shafts, of course, are the most common application there is for the process. The fact that such shafts can be safely rebuilt without having to be removed from the winding means a quite substantial savings and usually eliminates the necessity for rewinding, which almost invariably has to be done when a shaft is removed.

These then, are typical of the jobs being done today in the steam power plant. They should suggest many other possibilities on valve stems, crankshafts, and various other worn mechanical parts. They appear to be of real advantage to all types of operations, whether done by the

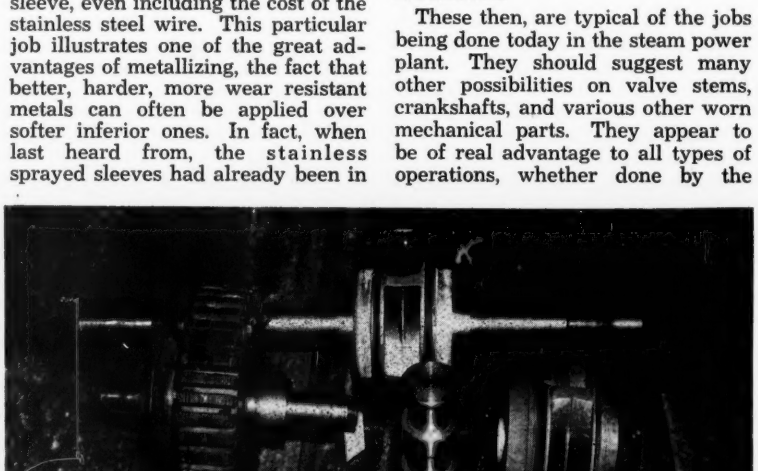


Fig. 5. A group of parts which have been reclaimed by the use of metallizing

plant itself, if large, or by outside metallizing contractors, if a plant is too small for its own complete shop.

Advantages of Metallizing

There are three main advantages in metallizing as used for a mechanical maintenance process. First is the speed. Modern units spray 3/16 in. wires at high speeds. For example, steel wires are sprayed at over 20 lb per hr. That means fast repairs at low cost. Second, metallizing is essentially a cold process. Little heat is generated and the temperature of the base can readily be maintained below 250 F. Hence, there is no danger of warpage or of the setting up of undesirable stresses in the base. Third, metallizing is tremendously versatile. Any one of almost 40 different kinds of metal can be sprayed onto almost any type of base, metallic or non-metallic. Hence, parts can be reclaimed with a material which will withstand the conditions of wear and corrosion better than that from which the part was originally made. Stainless steel over bronze as on the pump packing sleeves is an excellent case in point.

Operating engineers not already using metallizing in their mechanical maintenance program can well afford to investigate this modern "putting-on" process.

RECIRCULATION COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINES

By D. F. BIXLER

WHEN COOLING WATER is taken under pressure from the city water or plant mains, engine operation can be improved by using a hydraulic injector to recirculate part of the water leaving the engine. The installation, as shown herewith is simple, dependable, low in first cost and involves no operating cost.

Advantages are as follows:

(a) Water enters the engine at higher temperature so the cylinder is at a more even temperature at top and bottom.

(b) Flow through the jackets is about doubled, so there is better cooling in general and much less danger of hot spots where scale might deposit out of the water.

(c) There are no ice cold jackets where sweating occurs and results in water getting into the lubricating oil system.

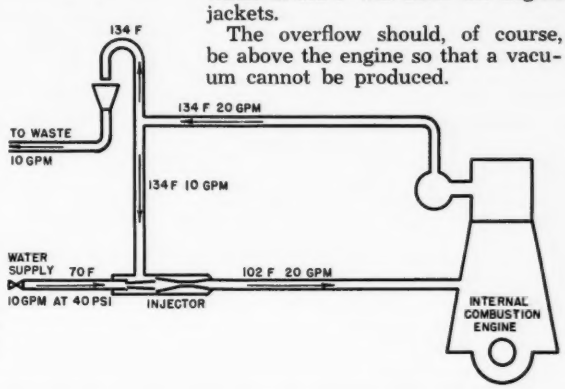
Sample Calculations—The following method works out satisfactorily. A 100-hp engine with a fuel consumption of 5 lb per brhp uses 50 lb of fuel per hour with 19,000 Btu per lb. Heat in the fuel is 50 × 19,000 or 950,000 Btu per hour. If 1/3 of the heat goes into the cooling water, it would be approximately 320,000 Btu per hour or 5300 Btu per minute. If water from the mains is at 70 F and leaving the engine is at 134 F it has picked up 64 deg or 64 Btu per lb. A gallon therefore picks up 8.3 lb per gal × 64 or 533 Btu. Gallons per minute of cooling water required would be 5300 ÷ 533 or approximately 10 gpm or 600 gal per hr.

A ¾-in. hydraulic injector of well-known make uses 665 gal per hr of operating water—with 40 psi pressure in the supply line, and would be the right size.

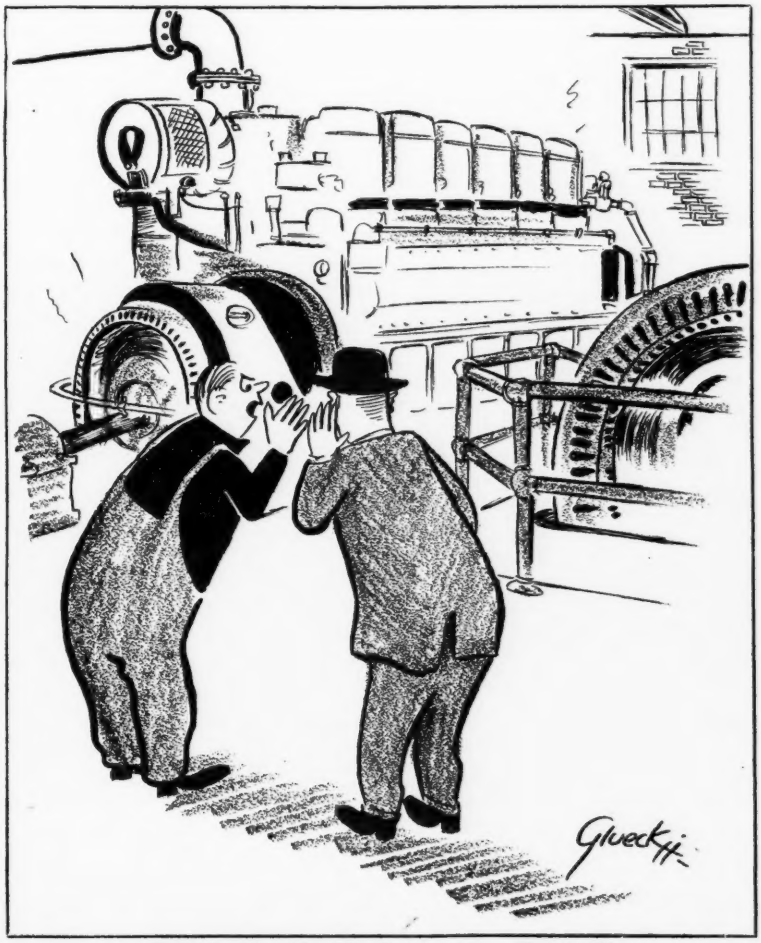
Water will be recirculated at about the same rate as the supply to the injector. Thus 20 gpm will go through the engine. It will be a 50-50 mixture of 70 F water and 134 F water and would be at 70 + 134) +2 or 102 F on entering the jackets.

Without the injector, 10 gpm of water at 70 F would enter the engine jackets. With the injector, 20 gpm of water at 102 F will enter the engine jackets.

The overflow should, of course, be above the engine so that a vacuum cannot be produced.



Recirculation cooling system for internal combustion engines, using injector, as proposed by D. F. Bixler



"I Said—Considerably Quieter Now, Eh Wot?"

PRACTICAL ENGINEER SECTION

The Case of the Creeping Lightning

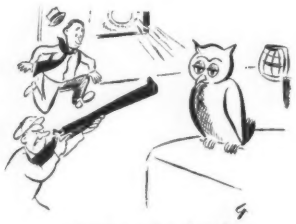
An adventure of Oscar, the Gas Works Owl, involving lightning, fire, hate, revenge, frustration, and incompetence. There will be other tales of this wise bird in future issues

By JOHN RAVEN

ENGINEERS who work around the gas works long enough, with sudden death always sneaking around like their own shadows, get to see and to believe, some mighty incredible happenings. For instance who would believe that an ordinary owl, the kind that screeches goose pimples onto your back, could read and write and solve a mystery quick as Sherlock Holmes?

I didn't believe it either, until the time lightning hit the tar storage building.

I had met Oscar the Gas Works Owl for the first time several months previously, as he sat on the firing roof of a creosote still. The sun was in his eyes, so he didn't see Elmer the



—drawing a bead on him

stillman drawing a bead on him with a 12 gauge shotgun. I hit Elmer's arm just in time to substitute the smokestack for Oscar.

"Would you spill blood on Good Friday?" I asked Elmer.

"Dang it," Elmer explained. "He scares me. He flies around here at night saying 'whooooooooooo', and it sounds just like my still is starting to blow up. Night 'fore last, I ran a ¼ mile before I realized it was nothin' but that danged owl."

Thereafter Oscar kept away from Elmer's still, suspecting no doubt that he wasn't welcome there, and I forgot all about the incident.

Then the tar house burned after being slugged by lightning, according to the Boss, and he said to me, "John, don't let this happen again," and I didn't have the faintest idea how to stop it from happening again. I didn't even know what made it happen the first time. I'm a mechanical engineer, not a lightning engineer, but most bosses don't know the difference, and expect any engineer to answer any question about anything. If you even hesitate, they get the idea you're not much of an engineer.

So I went out to the ruins and looked them over. The tar house had been a one-story building, totally sheathed in corrugated iron from ridge-pole to ground, and why it didn't just act as one big lightning rod suggested something out of the ordinary right away. Next, it was completely surrounded by much higher structures, all steel. For instance, on the north and south were high oil storage tanks, on the west was a big gas holder, while to the east and only 50 ft away, stood the

The tar house slugged by lightning

BASIC POWER PLANT FIGURING — 3

A Review for Old-Timers — A Must for Young-Timers

By WILLIAM H. ENGELMAN

IN PART 2, March issue, we noted briefly that, in reading steam tables (also in other kinds of tables to be shown later in these articles) it is often necessary to find values that lie somewhere between the values shown in the table. This is interpolation. Webster defines interpolation as "the method of finding from given terms of a series, as of numbers or observations, other intermediate terms in conformity with the law, given or assumed, of the series."

In all the tables you will use in engineering work, the decimal system of ten or multiples of ten, is used, so that the laws of the series of numbers are known, not assumed.

In using the steam tables (*Thermodynamic Properties of Steam*, by Keenan and Keyes) you will often have occasion to interpolate. Here is an easy and accurate way to do it, shown by examples.

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Problem 1:—Calculate the Btu per pound and the volume in cubic feet per pound for steam at 195 psia and 490 F total temperature.

Solution:—Neither value can be read directly from the table; hence, a double interpolation is necessary. Using Table 3, Superheated Vapor, interpolate first, by inspection, for 195 psia at both 480 F and 500 F. Then tabulate thus:

	ENTHALPY, Btu per Pound			VOLUME, Cu Ft per Pound		
PSIA	480 F	490 F	500 F	480 F	490 F	500 F
194	1258.5	.....	1269.5	2.743	.....	2.815
195	1258.4	1263.9	1269.4	2.7285	2.764	2.7995
196	1258.3	.....	1269.3	2.714	.....	2.784

For 195 psia and 500 F the value is 1269.4 Btu
For 195 psia and 480 F the value is 1258.4 Btu
Difference is 20 F in temp. and 11.0 Btu

and for 10 F is $\frac{11.0}{20} \times 10$, or $\frac{5.5}{1258.4}$

Answer 1263.9 Btu per lb.

For volume, follow the same method.

Problem 2:—Calculate the Btu per pound of steam at 191 psia and 504 F tt.

ENTHALPY, Btu per Pound			
PSIA	500 F	504 F	520 F
190	1270.0	.....	1280.8
191	1269.85	1272.02	1280.7
192	1269.7	.....	1280.6

520 − 500 = 20; 504 − 500 = 4; 1280.7 − 1269.85 = 10.85

$\frac{10.85}{20} \times 4 = 2.17$

1269.85 + 2.17 = 1272.02 Btu

steel smokestacks of a battery of stills. The stills were even on higher ground. I could see where the storm rain had cut little gullies right down to the concrete floor of the tar house. Fire from lightning didn't make sense.

I went over to the battery of stills, and yelled for the stillman who had been reported as a witness of the whole thing. He was atop one of his charges, grumbling at a welder who, crouched in a quivering blue light, was repairing a leak between the still drum and the steel smokestack.

He came down still grumbling and I recognized my old friend Elmer.

"You engineers ought to know what happened without me havin' to tell you over and over again," he said unpleasantly. "I went into the pump house to see if everything was OK and when I came out, I was almost knocked blind by the lightning. It was right behind the stills where the tar house was, it made a big bang, and right after that the flames commenced shootin' out every which way. It was rainin' cats and dogs, you know how it does after a big thunder clap, and the ground was like a lake. I buttoned up my raincoat and splashed over to the tar house but there wasn't nothin' I could do. That place was like a furnace, hissin' in the rain, and with the tar barrels inside goin' pop, pop, all the time."

Such was his story and he stuck to it. I suggested in a small voice that maybe the leaky still might have started the fire some way.

"How?" I couldn't tell him how, and Elmer was scornful. "That thing's been leakin' a week, day and night, and nobody's seen it torch off yet. Besides, I'd have seen it soon as I came out of the pump house, wouldn't I?"

I was licked and Elmer and I both knew it. Next morning I came to the gas works early to start packing my books and charts. You're either an engineer or you're not with my Boss, and I knew when to head for the gate.

When I got into the office, first thing I saw was my bottle of India ink overturned on my drawing board, and drained off into a drying

I knew I had to head for the gate

pool on the floor. Then I caught sight of my month's fuel reports where I had left them carelessly on my desk all night, while I thought of nothing but lightning, and they were criss-crossed with hen-tracks made with India ink. Right there I knew the Boss would say "You're fired!" before he even said good morning.

I picked up one of the reports to see if anything could be salvaged, and so help me, the tracks made sense. The report I examined showed an outline of something that suggested the stills and something else like the tar house, and they were connected by a single line on which had been scrawled the one word, "fire." I grabbed for another, and this time the tracks spelled

Elmer didn't like Oscar

PRACTICAL ENGINEER SECTION

***Problem 3:*—Find the Btu per pound of steam at 261.5 psia and 683.5 F tt.**

PSIA	680 F	683.5 F	700 F
260.0	1360.0	.....	1370.4
261.5	1359.9	1361.73	1370.34
265.0	1359.7	.....	1370.2

700 − 680 = 20 ; 683.5 − 680.0 = 3.5 ; 1370.34 − 1359.90 = 10.44

$\frac{10.44}{20} \times 3.5 = 1.83$

1359.90 + 1.83 = 1361.73 Btu

***Problem 4:*—Calculate the absolute pressure, total temperature, Btu per pound, and the volume in cubic feet per pound for steam at 815 psig and 350 F superheat with an atmospheric pressure of 29.0 in Hg.**

Absolute pressure is $815.0 + (29.0 \times 0.4912) = 829.24$ psia.

Temperature of sat. steam at 829.24 psia is 522.38 F
Degrees of superheat..... 350.00 F
Total Temperature is 872.38 F

	ENTHALPY, Btu per Pound			VOLUME, Cu Ft per Pound		
PSIA	860.0 F	872.38 F	880.0 F	860.0 F	872.38 F	880.0 F
825.0	1431.9	1438.96	1443.3	0.8991	0.9095	0.9159
829.24	.....	1438.8	.....	.....	0.9047	.....
850.0	1430.9	1437.96	1442.3	0.8711	0.8812	0.8874

Values for entropy are interpolated in a similar manner. Table 3, Superheated Vapor, gives the entropy values for certain pressures and temperatures from which other values are easily obtained.

The entropy values calculated for Problem 4 are as follows:

	ENTROPY, Btu per deg F. per Pound		
PSIA	860.0 F	872.38 F	880.0 F
825.0	1.6199	1.6252	1.6284
829.24	.....	1.6246	.....
850.0	1.6160	1.6213	1.6246

850 − 825 = 25 ; 829.24 − 825.00 = 4.24 ; 1.6252 − 1.6213 = 0.0039

$\frac{0.0039}{25} \times 4.24 = 0.0006$

880 − 860 = 20 ; 872.38 − 860.00 = 12.38 ; 1.6284 − 1.6199 = 0.0085

$\frac{0.0085}{20} \times 12.38 = 0.0053$

1.6199 + 0.0053 = 1.6252

1.6246 − 1.6160 = 0.0086

$\frac{0.0086 \times 12.38}{20} = 0.0053$

1.6160 + 0.0053 = 1.6213

1.6252 − 0.0006 = 1.6246 *Answer*

Values thus computed should always be checked with the ***Mollier Chart,*** also known as ***Total Heat-Entropy Diagram,*** or with the ***Thermodynamic Charts*** by F. O. Ellenwood and C. O. Mackey, second edition, 1944, John Wiley & Sons. The Thermodynamic Charts give the enthalpy, volume, entropy, and degree of superheat of a pound of steam direct, thus shortening the calculations.

NEXT TIME: How to use the Mollier Chart and how it shows in diagram form the steam table values.

PRACTICAL ENGINEER SECTION

words like "slep" and "lmr" and "gratetud."

I put them together on my desk like a jig-saw puzzle, and in ten minutes I had the whole story, exactly as it was seen by the eyewitness. Elmer it seems went to sleep in the pump house, and while he slept the leaky still caught fire and the burning oil floated downhill on the rainwater, got into the tar house and fired it. Pretty soon one of the big tanks in the storage house got too hot for itself and went off with a walloping bang that wakened Elmer and at the same time blew out the fiery fuse from the still. When Elmer got out into the rain, thinking he had been awakened by a thunder clap, there was nothing to be seen but the blazing building.

But the end of this fantastic message is what really sat me down for breath. It was signed, "seez al nos al n gratetud Oscar th gas wrks oul."

Elmer wonders who squealed on him and the Boss gave me a raise in pay. Here in the gas works they think I'm a pretty good engineer but they don't know about Oscar.

LETTERS TO THE EDITORS

(Continued from page 53)

as Allen Keller, the proponent of 100 per cent plant efficiency. On top of that I am an active reader of POWER GENERATION and expect to remain one so long as this splendid publication allows such gentlemen as Glenn Boyer and Allen Keller to fight it out in the pages of the magazine.

A professor should never ask his wife to get him a glass of water while he is in deep thought over the definition of thermal efficiency. He will then avoid fainting. A little walk to satisfy his thirst is very helpful—it will help him to remember that his own body is a prime mover, an engine working on the constant temperature cycle.

Mr. Keller has to sell a highly efficient piece of equipment. Selling one that has 15 per cent thermal efficiency makes for very poor sales talk. He is in need of a definition that will enable him to get the desirable figure of 100 per cent. People prefer to buy something with a high efficiency; therefore, Mr. Keller talks over-all performance of the plant where the turbine is installed. True, he considers the turbine, not as an engine, but as a supplier of something that the plant needs. The fact that the turbine is incapable of making use of the supplied energy is immaterial.

What Mr. Keller is attempting to say is this: Here is a turbine, a noncondensing one, its thermal efficiency is 15 per cent—that is all our turbine is capable of converting into mechanical energy, the energy used to drive the generator. Now, if we use the steam the turbine is rejecting for process work of some sort, it will no longer constitute a loss, hence the over-all plant efficiency will be increased. The efficiency of the process equipment is 85 per cent—no, not quite that for the bearings produce heat and there is waste from radiation and in the joints of the pipe lines. So say, the efficiency is 84 per cent. Now we have an engine which is 99 per cent efficient.

The turbine is now regarded as a supplier of steam that it is unable to use, but it *is* being used. Well and good, but just how should we evaluate the efficiency of a device that has no ability to impart energy to the substance it is sending out?

The turbine supplies (100—15) 85 per cent of what it took from the boiler. Now, the turbine becomes a supplier in its turn. The process equipment is making use of this 85 per cent (neglecting the 1 per cent loss) of the energy, or $0.85 \times 0.85 = 0.7225$ or 0.72. Now, add $0.15 + 0.72$ and we get 0.87. Thus the over-all plant efficiency is only 87 per cent, not 100 per cent as our salesman would like to make it appear.

Mr. Keller represents the manufacturer and I, as a consulting engineer, the client. He simply suggests to my client not to install a separate steam generator for his process steam, but to make use of the steam the turbine *must* reject. The client then has a centralized steam generator that supplies steam to the turbine and from the latter to process equipment. The salesman expects him to credit the gain thus obtained to the inefficient turbine. Why should the use of the rejected steam make his turbine 100 per cent efficient?

Mr. Keller, of course, knows all this. He is too good a designer to be fooled. He is looking at the over-all efficiency of the plant, not just the efficiency of the turbine alone. What must be kept clearly in mind is the fact that the total efficiency of a turbine-generator is not 100 per cent; also that the total efficiency of a plant is never 100 per cent. Let's keep the bookkeeping straight.

Philadelphia, Pa. Y. YAVITCH

▶ **Mr. Yavitch is correct when he says "Mr. Keller, of course, knows all this." As Mr. Keller pointed out in the last paragraph of his reply to Mr. Boyer on page 89 of the January issue, his article had to do with power plants, not engines. All people are not as well informed about these things as Messrs. Boyer, Keller, and Yavitch, and it was for that reason that Mr. Keller wrote his article. Whether the turbine should be regarded as a supplier of process steam, of course, depends upon the balance between the electrical load and the steam load, and each case requires individual analysis. There are cases where it is more desirable to purchase the electrical energy and install a boiler for the process steam. All that Mr. Keller asks, that all these things be considered and weighed carefully. There are many plants in operation throughout the country where they have not been correctly analyzed. These are plants where all three participants in this discussion, Boyer, Keller, and Yavitch, can be of real service.—Ed.**

CLOUDY OIL

BEFORE OUR expansion program of 1947, our oils and greases were kept in a room at one end of the boiler room basement. When our water softening plant was installed, this room was needed, consequently the oils were moved elsewhere. While the oil was in this room, the drums were emptied by hoisting them up by a crane hoist and then emptying them directly in to the tanks. When the room was vacated, the oil drums for the engine room were placed on timbers just outside the engine room door, in the boiler room basement, a valve having been previously screwed into the large opening of the drum. Later, the tanks were permanently placed back again where these drums now stood. The oil is now unloaded from the drums by compressed air.

This is done by inserting a special fitting into the drum with a pipe extending down into the drum nearly to the bottom, the other end running over to the tank opening. An air hose, with a special valve and gage, is placed in the small opening and about 5 psi air pressure put on the drum, whereby the oil is forced over into the tank.

The first time this was done, the oil was clear as ever, but the second time it was done, the oil came out very cloudy. Then from time to time, the oil would appear clear or cloudy, one time cloudy, the next time clear, maybe two times clear and one time cloudy. Thus the mystery increased.

The obvious cause was the use of air. But how? The oil was unloaded by different crews at different times but with the same results. Still no solution. We made tests and trials. We took a sample of oil and agitated it with air to make it turn cloudy but it would not. We tried mixing a little water with it, thinking maybe water was getting into the tanks (from hosing down or droppings from pipes) but this was not the cause.

Then, by very careful observation, I discovered the trouble! When the pipe extending from the drum over

to the tank was set up, it would sag at the end, due to its weight. Sometimes this end was left like this and sometimes it was propped up on a box. Since the tank will hold two drums of oil, if the the pipe is left sagging, the level of the oil will come up over the end of the pipe. If the pipe is propped up, it will not.

Here lay the trouble. The workman who took the trouble to prop up the pipe produced clear oil. But when the pipe was left sagging, and the oil came up over the end, the air, after the drum was empty, would blow down into the tank of oil, thereby making it cloudy.

It is doubtful if this cloudy appearance of the oil harms it in any way, but it was one of those mysteries that was fun to solve. There is always a solution to any of these peculiarities and this one was no exception. But it took us about six months to obtain it.

CHARLES W. PARKS

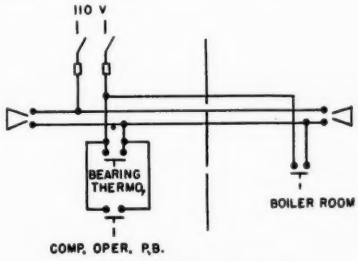
PRACTICAL HINTS AND KINKS

STEAM LOAD WARNING

By Gilbert Lindgren

When our 600 hp electric compressor suddenly shuts down it means that a sudden 600 hp load must be taken on by the boiler room.

To warn the boiler operator of this impending load we have extended our "hot bearing alarm" on this compressor so that the boiler operator is automatically warned of a possible added load. The two-way push button signal also provides a code of signals between the boiler operator and his main load.



Steam load warning system

HOW WE FIXED THE TURNING LINER THAT STOPPED THE AIR PUMP

By ALBERT H. MOULTON

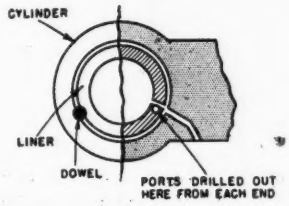
A VERTICAL, single-acting, twin-beam air pump serving a cross-compound condensing engine in our plant ran perfectly for a good many years with an occasional overhauling and a few repairs. But recently it began to give trouble by stopping now and then, causing loss of vacuum and slowing down the heavily loaded engine almost to a stop, if the engineer was not on hand to restart it at once, which was usually done by moving the pilot-valve rocker arm either up or down.

This behavior was most unpredictable; sometimes the pump would run steady as a clock for days at a time and then it would stop without warning and would be hard to start again. Then again, it would have spells of stopping every few minutes, for hours on end.

First, we thought that the mechanical lubricator was not feeding enough oil, so it was replaced by a new one, and for the next few days the pump made "nary a miss." But not for long; suddenly it began to act like its old self again (only more so) and our pride was set back, to say the least.

We changed the oil feed to about double and also the oil connection to the steam chest and pilot valve and we also changed the connection from the hand pump lubricator to feed directly to the pilot valve and pumped oil direct to it about twice an hour in addition to automatic feed. For several days she ran like a little lady and we began to throw out our chests again. This was it. But our sweet little lady suddenly got temperamental again, and this time she really acted up.

But hope springs eternal in the human breast. So one of us made an adjustment on the valve tappets and again there was a great improvement; for the next few days the pump ran much better, stopping only now and then. But suddenly she got really balky, again, was stopped about half the time.



Cross-sections through air pump cylinder and liner to show how turning of liner shut off steam ports and how lengthwise drilling opened the ports, as explained by Moulton

So, come Sunday, the valve chest was opened and when the main valve ports were looked into they seemed rather small. We were not sure whether they had been made that way or not, as we could not look directly into them. Accurate information was not immediately available, as the pump was 35 years old and that model had long since been discontinued.

So, it was put back together and the next day it acted as bad as ever. Wet steam? That was it! The steam supply to the pump was taken from the bottom of a steam main running to the mill and, while this was the original hookup, we figured that perhaps more water than usual was coming over to the pump and helping to cause the trouble. So, to get rid of the water, a drop leg was cut into the steam supply line near the throttle; this was drained by a trap to a closed heater.

But after about three days the old trouble was back. This was *most* discouraging and the mill was beginning to complain still louder about the unsteady power. So the next Sunday another examination was made of the main steam valve and this time a startling discovery was made! The main valve, a piston valve, steam operated from a mechanically-operated pilot valve, had a bushing or liner and this liner had rolled in its seat enough to nearly close the cylinder steam ports, choking off inlet steam and exhaust from the steam cylinders.

Apparently the liner had rotated back and forth a slight amount from time to time, shutting off the ports at irregular intervals. But while the liner could move in the hot steam chest, when everything expanded, nothing could move it when the steam was off, everything cold and the valve taken out. Then it was a shrunk fit.

To cure the trouble we drilled lengthwise into the liner from both ends, as shown in the sketch. This opened up the liner ports and brought them somewhat more in line with the ports in the valve chest casting. After drilling out the ports, the liner was dowelled to the cylinder to hold it from turning. Now the old girl runs beautifully again.

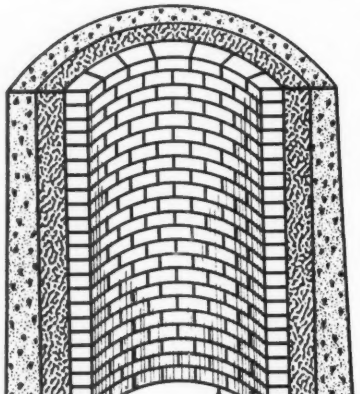
LARGE CHIMNEY INSULATED WITH MINERAL WOOL

TO PREVENT interior stresses in a 554-ft high concrete chimney, the International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario, Canada, has insulated, with loose mineral

wool insulation, a chimney believed to be the largest in the British Empire.

The concrete chimney-shell had to be protected from stresses resulting from a temperature difference of 850 F—from 800 F on the interior to as low as —50 F on the outside.

The chimney has an outside bottom diameter of 62 ft 1 in., an outside top diameter of 40 ft 8 in., a top wall thickness of 8 in., and a bottom wall thickness of 33 in. Its total height of 554 ft is lined with



Cross-section of 554-ft chimney showing how loose mineral wool insulation was used between radial brick lining and concrete outer shell

perforated radial brick, the bottom 75 ft being 5 in. thick and the remaining upper sections being 4 in. thick. Supporting corbels are protected by special ceramic corbel blocks, which permit the lining to expand both vertically and horizontally.

Space of 4 in. existing between lining and concrete chimney-shell is filled with loose mineral wool. Mineral wool was used in this application because, when properly applied, it remains in place without settling. It has this property because the fibers of the loose irregular mass knit themselves together and exert internal pressure on every part of the mass sufficient to support every part directly adjacent and above it. The weight of every part is not enough to exert a downward force sufficient to counteract this internal mass pressure, which is exerted in all directions.

* * *

Stainless steel wool should be used for cleaning stainless steel equipment to prevent surface contamination by other metals.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity. Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, co-operate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Question No. 438

HOW MUCH CAN APPLIED MOTOR VOLTAGE BE VARIED WITHOUT DAMAGE?

DURING THE WAR, it was common to see a 440-v motor connected to a 550-v line. Perhaps a good many of them are still so connected. What I would like to know is; how far can you juggle the applied voltage of a motor without damaging it at full rated load? Assume in all cases you do not rewind the motor.

To be specific assume a 10-hp, 440-v, 3-phase, 60-cycle motor of a standard 1948 model, 40-deg temperature rise, 1200-rpm (continuous rating) and let it be connected to a 550-v line. Then:

a. Would the motor still be rated for 10 hp?
b. What is the power factor, assuming that of the standard motor was 0.80 or 80 per cent?
c. What would be the efficiency change?
d. Would there be overheating or underheating?
e. Would the motor last longer or not?

How would those questions be answered if the motor were connected to a 660-v line or to a 330-v or 220-v line?

Woonsocket, R. I. M.N.

Answer No. 429

HE WANTS HELP ON POWER PLANT MAINTENANCE SCHEDULES

IF MY MEMORY is correct, I answered a similar question sometime in the past, describing the overhauling and maintenance method of one of the plants I was employed in. The principal difference between that method and Sergio Martinez' is that our record sheets were kept in a number of 3-ring binders, instead of in a card case.

One reason was that there were a number of plants on the system, and where similar conditions prevailed, the pages were sent out from the operating superintendent's office to the various plants involved, so that, as far as possible, a uniform system of records could be kept in all plants on the system. Another reason was that, at intervals, conferences of operators were held, and it was easier to bring the 3-ring binders to the conference than to bring cards.

In keeping up a maintenance schedule, I have found it important to have it meet two requirements:

1. Data relating to each individual piece of equipment must be filed so that it is readily available whenever needed.

2. The set-forward system must make it certain that on each day, or on each watch, the schedule will be complete as to the particular overhauling and maintenance jobs to be done at that time.

Los Angeles, California

HOWARD T. LIVINGSTON

Answer No. 436

HOW MEASURE COMPRESSED AIR SYSTEM LEAKAGE?

METHOD of doing this in one case may be quite simple; in another, quite complex. And, in some cases, does it do you any good to know it? Is wastage of compressed air in normal operation more important than leakage?

All these ideas and many others have been brought out in the following discussion of this question, asked by F.N.B. in the February issue. He wanted to know what other and better methods there are than the use of meters in the compressor discharge lines.

If the compressor is motor-driven, said Paul Wollner in the same issue, you can connect an electric clock in the compressor motor circuit to start and stop with the motor. Then, with all air outlets shut off, the clock will indicate the time

the compressor runs to make up leakage. That time, multiplied by the compressor capacity per unit of time, will give the leakage for the period.

If the compressor is steam-driven —well, our old friend Sam Williams tells how to handle that too.

Steam-Pressure Actuated Switch Will Do It

IN THE CASE of a steam-driven compressor, connect a pressure-actuated switch to the steam chest of the engine so that the switch will operate the electric clock when the engine starts.

This could be a permanent installation to furnish a constant check on air consumption. Simply work out a set of figures, showing running time compared with air output, and chart the figures for ready reference.
Pawling, N. Y. SAM WILLIAMS

Meter OK in Most Cases; Ears Good Too; But Wastage May Cost More than Leakage

THIS QUESTION of compressed air leakage deserves considerable attention because so few operators, and even fewer users, have an adequate understanding of the cost of this commodity.

We have checked periodically to determine compressed air leakage in our plants for a number of years. These tests are usually made on weekends when the plants are shut down and it is known that maintenance and repair work will be at a minimum. Ordinarily this does not give us too many opportunities during the year; but, on the other hand, we have found that system leakage does not vary too widely.

In the plants having a number of compressors of varying capacities, it has always been easy to determine system leakage by operating successively smaller compressors until one is found which is, roughly, capable of maintaining normal pressure. In one plant, where all compressors are of the same rating, we determine system leakage by observing the graduated unloaders. Such methods generally give us all the information we require.

The chief value of reliable leakage information lies in the fact that it serves as a challenge to the maintenance forces. As far as checking for individual leaks is concerned, nothing can take the place of a few pairs of good ears when the plant is not operating. Wastage due to extravagant use is far more of a problem than leakage.

We have tried electric clocks or time recorders and watt-hour meters, but the results were of no value on compressors equipped with unloaders because of the many variables involved. Such methods would provide reasonably accurate information only on small compressors equipped with pressure control. We have heard of attempts to determine leakage by plotting drop in pressure against time after all compressors had been shut down. Such a method, however, appears to introduce considerable opportunity for error, both in determining system volume and in correlating the secured data with a pressure-flow relationship, which is not a straight line function.

In one instance we did purchase a small (1000-cfm) and reasonably low-priced meter of the bypass type, which served to locate areas where extravagant use of air was suspected. The meter in this case paid for itself within a week.

F.N.B. does not state the size of his compressor installation, but if his system is such that the entire output is delivered through a common line and he feels that he really needs accurate information on leakage, nothing can take the place of a meter. Lord Kelvin was absolutely correct when he stated over sixty years ago that if you can measure what you are speaking about and express it in numbers, you know something about it, but when you can not measure it, your knowledge is of a meager and unsatisfactory kind. One of these relatively low cost meters installed in a bypass with suitable valves will give F.N.B. the story whenever his plant is shut down.

Any other method, because of the variables involved, will result, at best, in an approximation. He should bear in mind, however, that the meter will show only leakage and will not provide any clue as to wastage due to improper or extravagant use of air during working hours. We find that the latter costs us more than the former.

It would seem that the method F.N.B. should adopt depends entirely on his particular installation and the accuracy with which his determination must be made, together with the opportunity that may exist for improving economy.
Bridgeport, Conn. B. G. FORBES

Use Bypass Orifice; Compressor Speed; Unloader Operation

ONE WAY to check the leakage in a compressed air system is to provide a bypass around a main valve in the air line and try various orifices in the bypass. By measuring the pressure drop through any orifice when the load is shut off, the air passing can be computed close enough for practical purposes.

If the compressor is steam driven, with throttling regulation, it should be possible to find out what speed is required to maintain air pressure on the line when the load is cut off. If the cylinder rings and valves are in good order the percentage of air pumped should be about proportional to the percentage of full speed. If the compressor has automatic unloading, a few minutes' observation with a stop watch should enable the engineer to determine what percentage of the time is required to make up the leakage losses when the load is off.
Piney River, Va. IRA A. BUTCHER

PRACTICAL ENGINEER SECTION

Answer No. 437

HOW DESIGN OVERFLOW PIPE FOR CLOSE LEVEL CONTROL?

IN THE February issue, A.H.M. showed a sketch of a water tank, Fig. 1, in which it is necessary to limit water level rise to 6 in. if the float valve fails to close tight. If an overflow pipe were used to do this, he asked, how should it be sized to take account of the fact that there will be only a very small head of water over the overflow pipe inlet, with the result that there may be turbulence, air entrainment and the

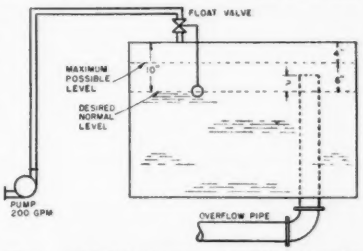


Fig. 1. Original diagram of A.H.M.'s water tank in which he wants overflow pipe to limit level rise to 6 in.

like at the entrance? These would affect the flow of water into the pipe entrance. How would they affect the pipe design?

Here are two comments showing how to eliminate the anticipated troubles by solving the problem in two different ways.

Eliminate Overflow; Control With Mercury Switch

WHY BOTHER with overflow pipe? Adjust A towards B or C, Fig. 2 for desired level control; or adjust incline of mercury switch—all provided pump is motor-operated.
New York City H. E. JONES

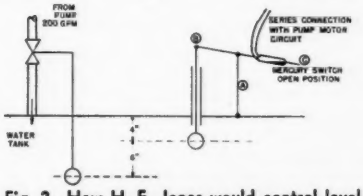


Fig. 2. How H. E. Jones would control level in A.H.M.'s tank by controlling pump operation with mercury float switch

Use Overflow Weir Instead of Pipe

UNLESS A. H. M. has had experience in computing flow of liquids through pipes, I would advise him to go slowly in attempting to make such computations, because a num-

ber of variables are involved, and an error in substituting any of them in the formulas will make a large variation in the computed results. My suggestion is: contact some instructor in hydraulics and ask his assistance. However, make sure, first, that the instructor has had actual experience in pipe design and did not learn all his hydraulics out of a book.

A. H. M. didn't supply enough data for me to work his problem out for him, but by making a few assumptions, it looks as if a 4 in. overflow pipe will do the work.

If A. H. M. will look in the back pages of a Crane Co. catalog, he will find one chart that will give him the equivalent pipe lengths of the various pipes, fittings, etc. which, added up, will give the equivalent length of straight pipe of his overflow pipe.

On another page of the same catalog, he will find a table of pressure drops for the flow of liquids through pipes. By balancing the pressure drop against the head available for pressure, he can determine the carrying capacity of various sized pipes. However, it is in the use of these two charts, or any of the various other formulas, that require the experience that I have mentioned.

I had a similar problem in a power plant where I was one of the designing engineers, so if I outline our method of solution, it may help A. H. M.

There were four condensate surge tanks, each serving the condenser of a steam turbine. Each tank had a 10 in. overflow nozzle welding into a flange; this flange in turn was welded into the side of the tank near the top. As condensate storage capacity was quite valuable, the maximum high water level was set at 2 in. below the top of the tank, which was well above the opening in the overflow pipe. Therefore, a weir was built in the tank, as shown in the sketch.

The overflow area over the crest of the weir was set at four times the cross-sectional area of the pipe. This area divided by the length of the crest of the weir was approximately four, so 4 in. was taken as the allowable variation in water level in the tank. Then 2 in. + 4 in. =6 in., which was the distance of the crest of the weir below the top of the tank.

Instead of the arrangement shown on A. H. M.'s sketch, I recommend that he use the arrangement I have just described.

Suppose, on advice of an engineer supplied with complete data, A. H. M. installs a 4 in. overflow pipe. The transverse area of Schedule 40 pipe, 4 in. size, is 12.73 sq in. and 4 times this is approximately 50 sq in., the overflow area over the crest of the weir. Now, suppose he installs a weir with a length of crest L=25 in., then 50÷25=2 ins. A. H. M. has set his maximum water level at 4 in. below the top of the tank. Then, 4+2=6 in., the distance of the crest of the weir below the top of the tank.

A check by an engineer on the job and familiar with all the factors involved may find it better to vary some of the quantities I have used

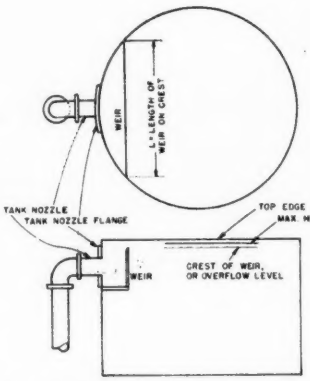


Fig. 1. Sketch by Livingston how he would use overflow weir instead of overflow pipe to get close control in A.H.M.'s tank

or assumed, but I am sure the principles will apply.

As to the plant I helped design, the first unit went on the line in 1943, and the four tanks have proved satisfactory; so much so that similar reasoning was followed in designing surge tanks for some more recent plants.

Los Angeles, Calif. HOWARD T. LIVINGSTON

Editor's Note:—Theory of overflow weirs is discussed on page 42 and their design on page 121, Applied Hydraulics, by Herbert Addison (John Wiley & Sons, Inc.) There is also considerable discussion of weirs in Hydraulics, by LeConte (McGraw Hill Book Co.) and in Hydraulics, by Hughes and Safford (Macmillan Co.)

Funnel on Overflow Inlet Forms Weir, Which Can Be Calculated

DIAGRAM shown by A.H.M. is reproduced here with only a slight modification, which is a funnel on the top of the overflow pipe.

The diameter of the top of the funnel can be determined by considering the top of the funnel as a weir and then looking up in a reference or text book the amount of water that will flow over a weir 12 in. long with a given head. Such data, plotted as a scale are given in Marks Mechanical Engineers' Handbook, Third Ed., page 267, for the Francis formula.

There are many kinds of weirs and, likewise, a wide variety of formulas for determining the flow over them. However, for practical purposes the funnel in question may be considered and built as a sharp-edge weir, making the crest about ⅛ in. wide.

The Francis formula for rectangular weirs is

$Q = 3.33\ (b - 0.2\ H)\ H^{3/2}$

where: Q=cu ft per sec; b=breadth in feet of the notch or length of the weir; H=head in feet above the crest, measured by the hook gage.

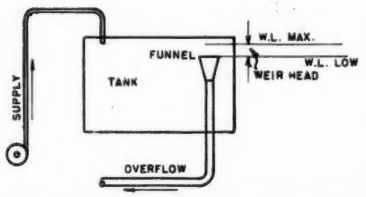
The above formula does not take into consideration the velocity of approach, which may be neglected in this case.

Tables based on the above formula indicate that 199.8 gpm will flow over a weir 12 in. long when the head reaches 3¼ in. (See *Practical Design Handbook for Engineers*, by Cibulka, part 7, page 25, Tables of Weir Discharge).

Because the flow converges inside the funnel, the flow will be reduced somewhat, but not seriously, perhaps 15 per cent.

The same tables indicate a flow of 269 gpm for a 4-in. head, 370 gpm for a 5-in. head and 476.5 gpm for a 6-in. head.

From the above it would appear that a funnel 6 in. in diameter with an overflow pipe 2½ in. or 3 in. in diameter will answer the requirements. The total length of the overflow line will determine the size required, as the friction coefficient, or



Sketch by Ira A. Butcher showing how funnel at top of overflow pipe in A.H.M.'s tank will act as a weir, over which discharge may be calculated for small heads

head loss, for 200 gpm flowing through a 2½-in. steel pipe is 46.3 ft per 100 ft of pipe. For a 3-in. pipe, the loss of head is 18.0 ft per 100 ft of pipe.

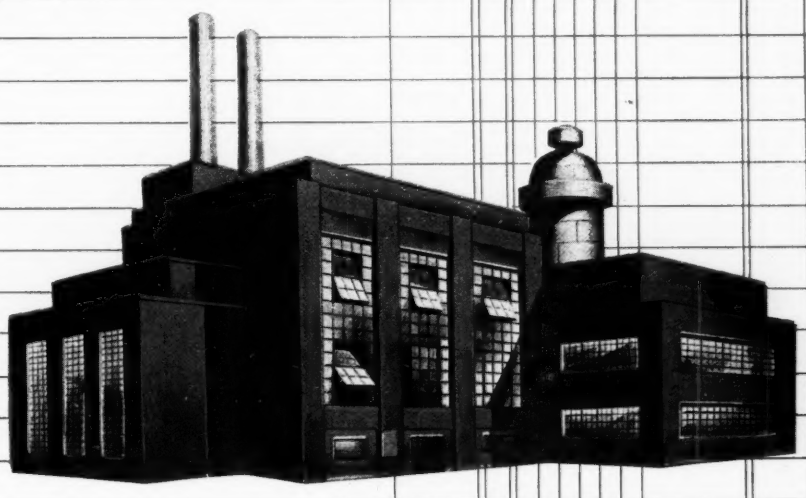
It is of interest to note that the various formulae do not give identical results by several percent, so judgment and experience must be used in solving the problem.

The slope of the sides of the funnel should be quite steep, say 15 deg from the vertical.

If the overflow is larger than necessary, air or gas will be entrained in the outflowing stream, but this should not be the cause of serious cavitation with the head involved.

Piney River, Va. IRA A. BUTCHER

HOW TO PROTECT AN INVESTMENT



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Goodyear Builds New Boiler Plant at Jackson

Two pulverized-coal-fired steam generating units, each of 100,000 lb per hr capacity, formerly used at Chickasaw Ordnance Plant, installed by the Goodyear Tire & Rubber Co. at Jackson, Mich . . . Reduce total steam temperature from 700 F to 477 F to fit new heat balance . . . New building duplicates old dimensions, to facilitate re-installation or boilers, piping and auxiliaries . . . Turbine and motor drives on pumps and fans; details of steam pressure sytems; change in auxiliaries

CONSTRUCTION of a steam generating plant as part of a modernization program designed to replace and supplement obsolete equipment was completed in late October 1948, by The Goodyear Tire and Rubber Co. of Jackson, Michigan. The new plant includes two 100,000-lb-per-hr pulverized-coal-fired boilers, capable of increasing the plant's steam capacity by 70 per cent. These were formerly used at the Chickasaw Ordnance plant in Millington, Tenn., and were purchased from WAA.

Construction of the new steam plant was necessary because of the reconversion of the Jackson plant in 1945 from military production back to a tire plant. To meet the great pent-up demand for tires and tubes, the plant's production was to be increased 28 per cent over prewar levels, resulting in a need for additional steam.

A new building, Fig. 1, was completed in Jackson, housing the two type VU, 100,000-lb-per-hr, 550-psi steam generators and all auxiliaries. The new building duplicated the exact dimensions of the one in Millington, Tenn., from which the equipment came, and re-erection of the high pressure piping and coal bunkers was completed without serious difficulty.

New Heat Balance

For heat balance under the new conditions in Jackson, it was necessary to change the total steam temperature at boiler outlet from 700 F at 550 psi to saturation temperature of 477 F at 550 psi. This entailed replacing the superheater tubes with short loop tubes running between the superheater inlet and outlet headers.

The original installation was set up with all auxiliary steam-driven equipment discharging into the 50 psi service header. However, because the plant requirements for 50 psi steam are limited by the 200,000 lb per hr, deaerating feedwater heater, it was necessary to change the discharge pressure of two boiler feed pump turbines to 5 psi and to motorize the third one. The exhaust steam from drives on the automatic control system oil and air control pump, as well as the fuel oil pumps, discharges into the 5-psi system, which also supplies part of the plant heating system, and heats city water makeup in a hot-process lime-soda softener. See Fig. 1.

The two steam generators deliver dry saturated steam to a system of steam headers from which two 3-in. pressure-reducing valves reduce the pressure from 550 psi to 200 psi for the old power plant steam header.

In addition to the auxiliary steam supply outlets provided on each boiler, an 8 in. blank is provided for future turbine generator connection. In the engine room, pressure-reducing stations step the steam down to 155 psi and 100 psi for process services and to 5 psi for heating.

Boiler Water Supply

Jackson city water, with a hardness of 19 grains per gallon, passes through a heat exchanger where its temperature is raised from 52 to 62 F by heat recovery from flash-tank discharge water. It is then softened in the softener where its temperature is increased to 223 F. Softened water is mixed with factory and heating system return condensate, the make-up representing approximately 50 per cent of total boiler feed. Two new transfer pumps pump the water from the softener to the 200,000-lb-per-hr feedwater heater, which raises its temperature to 298 F. From there, the boiler feed pumps deliver it to the boilers.

Phosphate and sodium sulphite are fed directly into the boiler drums to maintain oxygen-free water of zero hardness. Total solids concentration, not to exceed 2500 ppm, is controlled by continuous blowdown control.

Fuel Supply and Firing

Coal from Southern Ohio fields arrives in hopper-bottom cars, from which it is dumped into a track hopper. It is transported to the coal crusher, then over a magnetic separator pulley, and is then elevated to a 160-ton overhead coal bunker for each boiler. From the bunkers, coal discharges into coal scales, where it is weighed and dumped automatically into hoppers over the pulverizer feeders. Each boiler is equipped with two Raymond bowl mill pulverizers and exhausters, with two burners per mill or four per boiler, firing horizontally into the furnace front. One mill will carry approximately 70 per cent of rated boiler capacity. Burners are designed to take mechanical-atomizing oil burners both for lighting off and supplementing coal in emergency.

The air-hydraulic combustion control system maintains proper fuel-air ratio automatically by

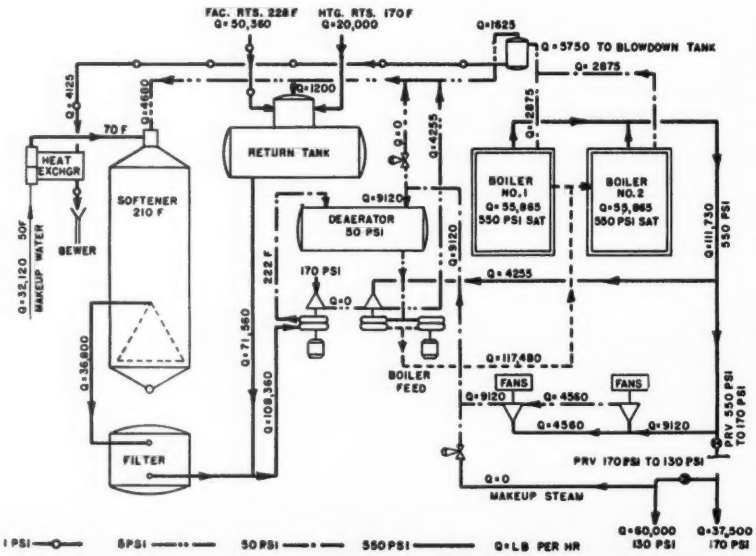

Fig. 1. Heat balance diagram of new boiler plant of Goodyear Tire & Rubber Co., at Jackson, Mich.

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FIG. 456-P

ALSO DESIGNED FOR 450-650 LBS. W.S.P.

Ernst Monel Metal and Bronze Combination TRY COCK

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FIG. 13

This Ernst Leakless Try Cock assures maximum safety in boilers with pressures up to 450 lbs. Disc can be replaced under full boiler pressure. Sizes ½", ¾" or 1". Other Try Cocks for pressures up to 2500 pounds.

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Fig. 15

Working pressures up to 250 lbs. This Double Chain Pull Try Cock insures a tight shut off. Sizes: ½" or ¾".

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LIP MOLD Fig. 21

STANDARD Fig. 22

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Fig. 2. (Above) Front of one of the 100,000-lb-per-hr, 550-psi steam generating units at Goodyear's new Jackson boiler plant

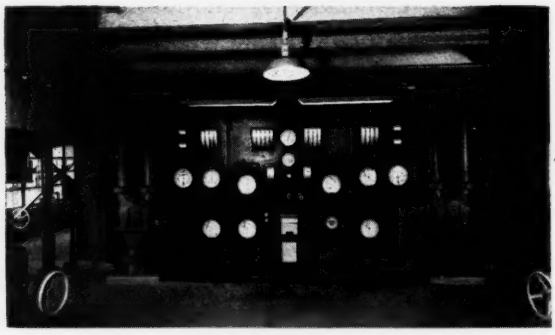

Fig. 3. (Upper right) Main boiler control panel for two 100,000-lb-per-hr boilers at Goodyear's new Jackson boiler plant

Fig. 4. (Right) Coal feeders for pulverizers, two per boiler, serving two 100,000-lb-per-hr boilers at Jackson

means of a totalizing valve and squaring modulator, which adjust the air and fuel flow to meet steam demands. The furnace draft is maintained automatically by an induced-draft fan regulator.

Fans and Drives

The induced-draft and forced-draft fans are of the duplex type, one shaft carrying both fan rotors between two pedestal bearings. The fans are enclosed in separate housings with individual inlet damper control. Moreover, fan speed is controlled in proportion to the steam demand by an automatically-operated steam inlet valve on the driving turbine. Turbines at 5200 rpm drive fans, through speed reducers, at 900 rpm maximum. Fan turbines take steam at 550 psi, exhaust at 50-psi to the deaerating heater.

A vacuum-type ash-handling system discharges ash from the dry bottom furnaces to an outside 50-ton tile bunker. Boiler and flyash precipitator hoppers are also cleaned by this vacuum system. Furnace gas leaving the air heater enters the fly-ash precipitator, then passes through the ID fan to the stack. This precipitator is designed to remove 83 per cent of all dust and 95 per cent of the entrained solids of 20 microns and over.

PRELIMINARY PROGRAM ELEVENTH ANNUAL MEETING MIDWEST POWER CONFERENCE

April 18-19-20, 1949
Sherman Hotel, Chicago

Monday, April 18, 1949

8:30 A.M. Registration, Sherman Hotel.

10:00 A.M. Opening Meeting. Chairman: Alex D. Bailey, Vice President, Commonwealth Edison Co., Chicago.

(a) Address of Welcome. Ben G. Elliott, Chairman, Department of Mechanical Engineering, University of Wisconsin.

(b) Can Socialism Produce for the U. S.?, J. W. McAfee, President, Assn. of Edison Illuminating Companies.

(c) Electric Power Supply and National Security. Edward Falck, Director, Utilities Branch, National Security Resources Board, Washington, D. C.

12:15 P.M. Joint luncheon with A.S.M.E. Chairman: W. H. Oldacre, Chairman, Chicago Section, A.S.M.E.

Speaker: Arrangements Pending.

2:00 P.M. Modern Steam Generators.* Chairman: R. B. Gutekunst, Chairman, Power and Fuels Division, Chicago Section, A.S.M.E.

(Sponsored and arranged by Power and Fuels Division, Chicago Section, A.S.M.E.)

(a) Evolution of Today's Central Station Boiler. E. M. Powell, Design Engineer, Combustion Engineering-Superheater, Inc., New York.

(b) Present Developments in Boiler Design. Frank X. Gilg, Application Engineer, The Babcock and Wilcox Co., New York.

2:00 P.M. Power System Planning. Chairman: E. W. Kimbark, Northwestern University.

(a) Economic Factors in Transformer Application. L. LeVesconte, Sargent & Lundy, Chicago.

(b) Cost of Supplying Electrical Losses. Paul H. Jeynes, Public Service Electric and Gas Co., Newark, New Jersey.

3:30 P.M. Feedwater Treatment No. 1. Chairman: M. P. Cleghorn, Iowa State College.

(a) Feedwater Treatment for the 100 Percent Makeup 1500 psi boilers at Whiting, Indiana. Glen Hull, General Foreman, Utilities Division, Standard Oil Co. of Indiana, Whiting, Indiana.

(b) Feedwater Conditioning at the Steel Co. of Canada, Ltd. A. C. Elliott, Asst. Combustion Engineer, The Steel Company of Canada, Ltd., Hamilton, Canada.

3:30 P.M. Network Analyzers and Analog Computers. Chairman: E. B. Kurtz, State University of Iowa.

(a) A 10,000 cycles Network Analyzer. W. B. Boast and J. D. Ryder, Professors of Electrical Engineering, Iowa State College.

(b) The Anacom, The Analog Computer, Applied to Mechanical and Electrical Problems in Power Systems. D. L. Whitehead, Central Station Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

Tuesday, April 19, 1949

9:00 A.M. Small Power Plants. Chairman: Clifton R. Harding, President National Association of Power Engineers.

(Sponsored and Arranged by the N.A.P.E.)

(a) Design of Small Industrial Power Plants, Parker Moe, Consulting Engineer, Gates, Moe, Weiss & Tatenheim, Consulting Engineers, Milwaukee, Wisconsin.

(b) What Can A Small Plant Do About Fly Ash? Carl E. Miller, Technical Advisor, Battelle Memorial Institute, Columbus, Ohio.

9:00 A.M. Control Characteristics of Industrial Processes. Chairman: K. W. Miller, Armour Research Foundation of Illinois Institute of Technology.

(a) Significance of the Process in Problems of Thermal and Flow Regulation. Albert F. Sperry, President, Panellit Inc., Chicago.

(b) Significance of Controller Dynamics in Electro-Mechanical Systems. Richard W. Jones, Associate Professor of Electrical Engineering, Northwestern Technological Institute.

10:30 A.M. General Session. Chairman: W. A. Lewis, Illinois Institute of Technology.

(a) Power Supply and Requirements in the United States. E. R. de Luccia, Chief, Bureau of Power, Federal Power Commission, Washington, D. C.

(b) Present Status of Atomic Power. Dr. Norman Hilberry, Deputy Director, Argonne National Laboratory, Chicago.

12:15 P.M. Joint Luncheon with A.I.E.E. Chairman: F. D. Troxel, Chairman, Chicago Section, A.I.E.E.

Speaker: T. G. LeClair, Assistant Chief Electrical Engineer, Commonwealth Edison Co., Chicago. "Power

* A short discussion is included at the end of each technical session.

TUBE-TURN

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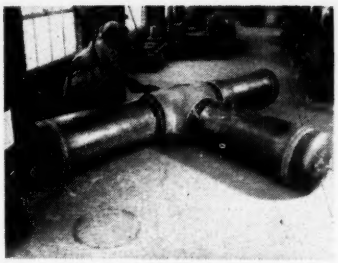
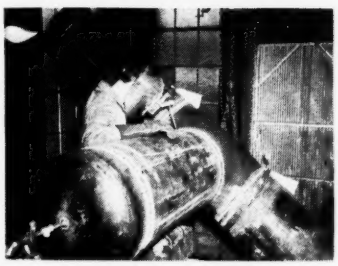
WELDING FITTINGS AND FLANGES

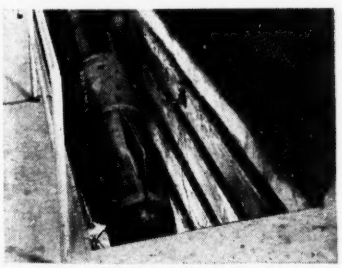


18-inch standard weight Tube-Turn welding tee and pipe laid out preparatory to assembly for hydrostatic pressure test.



Welder completing last bead in assembly. Fitting and pipe now form homogeneous, leakproof unit.

Assembly is hung in pit, massively lined with concrete. During test top grating is closed and held down by a barricade of sandbags.



Final result after hydrostatic pressure test. The straight pipe burst first, and the tee is undamaged.

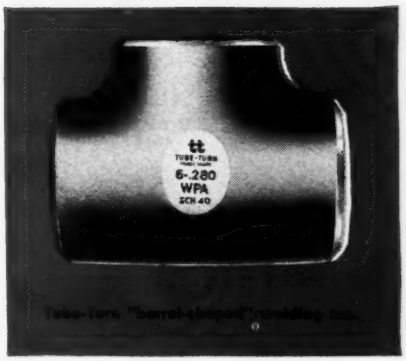
Strength through Design in Tube-Turn welding fittings

The pipe burst first!

Take an 18-inch standard weight welding tee. Take three corresponding lengths of pipe. Weld tee and pipe together. Cap the ends. Lower the assembly into a pit. Then apply hydrostatic pressure—much more than the assembly is supposed to take!

Something has to give! According to the accepted beliefs it should be the tee. But not in the case of the test pictured here. The Tube-Turn "barrel-shaped" tee was used—and the pipe burst, well before the tee was affected! Throughout numerous tests, this new type of tee has withstood at least 25 per cent more pressure than required by the formula given in ASA B16.9.

The superior strength of the tee was achieved without running up extra weight and cost, by carefully planned improvements in shape (based on the sphere, nature's strongest form for internal pressure), and by a carefully engineered distribution of metal.



Tube-Turn "barrel-shaped" welding tee.

This is a typical example of *strength through design* in Tube-Turn welding fittings, and another good reason why leading piping engineers specify Tube-Turn equipped, welded piping.

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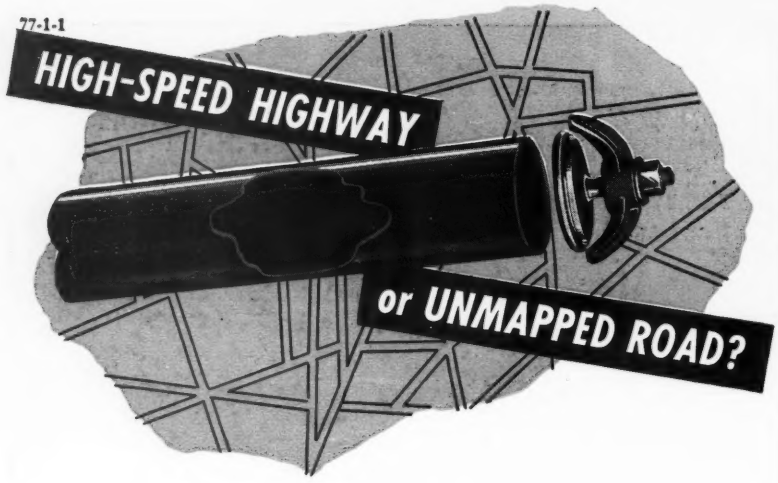

MODERN boiler design assures good planning — quality fabrication and erection, good construction.

But it's surface maintenance that determines whether boiler tubes will carry the heavy traffic of high pressures, temperatures and ratings at through-way — or just back-road — efficiency.

That maintenance starts, for the new boiler, before it goes into service. Over a base of clean, bare metal, APEXIOR NUMBER 1 lays a surface that takes the wear and takes it better than does any boiler steel.

Insoluble in all boiler waters, APEXIOR frees metal from threat of corrosive attack from causes known and unknown — smooths it so that deposits adhere less readily and can be removed more easily, at less cost.

That's why every tube of the APEXIORized boiler is a high-speed highway that steps up circulation and evaporation — keeps heat-transfer efficiency high and heat distribution uniform — assures maximum availability.

This new bulletin gives all the facts about APEXIOR Protective Surfacing for tubes and drums, in boilers new or old. A copy is yours for the asking.

DAMPNEY Maintenance for Metal

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2:00 P.M. Central Station Equipment. Chairman: Ben G. Elliott, University of Wisconsin.

(a) Suction Intake Design For Vertical Circulating Pumps. W. Wiltmer, Engineer, Centrifugal Pump Dept., Allis Chalmers Manufacturing Co., Milwaukee, Wisconsin.

(b) Recent Developments in the Design of High Pressure, High Temperature Steam Turbines. C. W. Elston, Division Engineer, Steam Turbine Engineering Division, General Electric Co., Schenectady, N. Y.

2:00 P.M. Feedwater Treatment No. 2. Chairman: L. G. Miller, Michigan State College.

(a) Water Treatment For the High Pressure Plant. Louis Wirth, Jr., Supervisor, Power Division Laboratory, The Dow Chemical Co., Midland, Mich.

(b) Removal of Silica From Boiler Feedwater by the Sludge Blanket Hot Process Softener and Exchange Methods. J. D. Yoder, Vice President, The Permutit Co., New York.

3:30 P.M. Distribution Systems. Chairman: E. T. B. Gross, Chairman, Power Group, Chicago Section, A.I.E.E.

(Sponsored and arranged by Power Group, Chicago Section, A.I.E.E.)

(a) Resonant Grounding of Distribution Systems. E. Herzog, Electrical Engineer, Army Air Forces, Wright Patterson Air Base, Dayton, Ohio.

(b) A 33 kv Inter-Connected Sub Transmission System with the Development and Operation of 4 kw Networks. William R. Waugh, Relay Engineer, Indianapolis Power and Light Co., Indianapolis, Ind.

3:30 P.M. Central Station Operation. Chairman: N. A. Parker, University of Illinois.

(a) Evaluation and Location of the Losses in a 60,000 kw Power Station. C. Birnie, Jr., and E. F. Obert, Northwestern Technological Institute, Evanston, Ill.

(b) Purification of Water by Compression Distillation. E. T. Erickson, Erickson Chemical Co., Chicago.

3:30 P.M. Maintenance Problems of Small Plants. Chairman: J. W. Andeen, University of Minnesota.

(a) Preventive Maintenance Program For Small Plants. Leland J. Mamer, Chief Engineer, Evanston Hospital, Evanston, Ill.

(b) Maintenance of Package Boilers. F. W. Hainer, Vice President, Cleaver-Brooks Co., Milwaukee, Wisconsin.

6:45 P.M. "All Engineers" Dinner. Informal. Grand Ball Room. (Ladies Invited.)

Wednesday, April 20, 1949

9:00 A.M. Heating and Air Conditioning. Chairman: William Goodman, Illinois Institute of Technology.

(a) Room Air Distribution in Year Round Air Conditioning. G. L. Tuve, Head, Department of Mechanical Engineering, Case Institute of Technology, Cleveland, Ohio.

(b) Transmission of Heat by a Fluid Carrier. Samuel R. Lewis, Samuel R. Lewis and Associates, Chicago.

9:00 A.M. Electricity in Farm Industry Comes of Age. Chairman: D. D. Ewing, Purdue University.

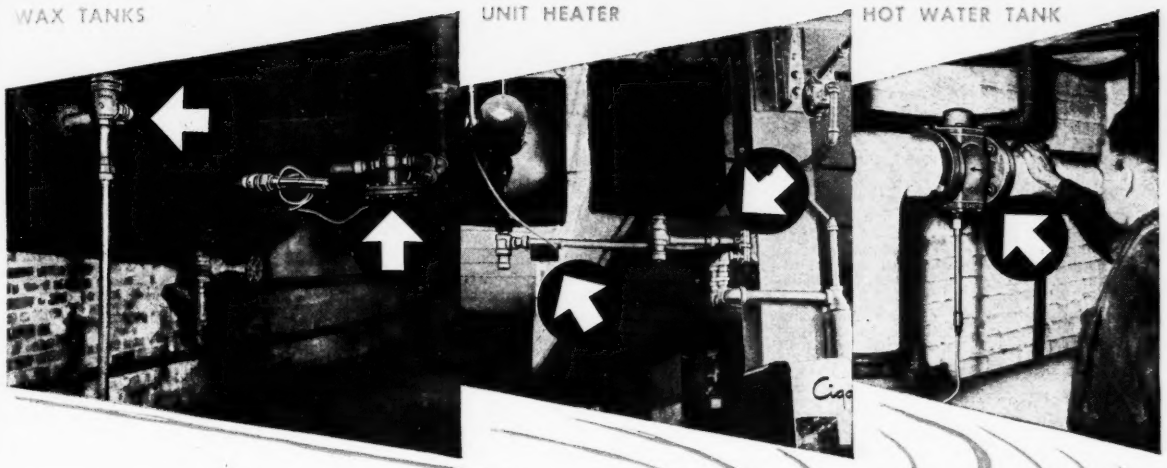
(a) Electrifying Farm Productive Equipment. J. H. Oliver, In Charge, Product Development, Farm Industry Division, General Electric Co., Schenectady, N. Y.

(b) Providing Adequate Service on Rural Power Systems. R. F. Quinn, Manager, Line Apparatus Equipment, Agency Division, General Electric Co., Schenectady, N. Y.

9:00 A.M. Symposium on Steam Contamination. Chairman: R. T. Hanlon, National Aluminate Corporation, Chicago.

(a) Carryover Types and the Effect of Design of Drum Internals Upon Steam Contamination. P. B. Place,

(Continued on page 110)



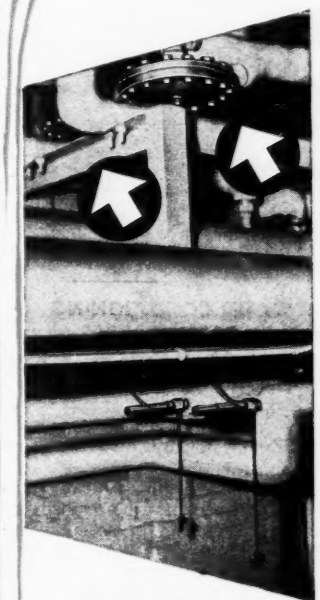
HOW SARCO SAVES FUEL

"I've been paying for Sarco Steam Traps and temperature controls for years in wasted heat. Thought I might as well have them and the other advantages too."

This statement was made by executives who knew the facts, but just "never got around to it."

Take the wax tanks illustrated. Tons of hot wax are stored, and poured into 100 lb. paper bags for shipment. Too cold—it won't run. Too hot, it burns or ruins the bags and wastes heat. The Sarco No. 9 Steam Trap at the left extracts all usable heat in the steam coils before it lets the condensate go. The Sarco Control at the right, holds the temperatures within a degree—and again, saves steam.

Unit Heaters start and stop at the command of Sarco Electric Controls. Hot water is held at correct temperatures in converters and tanks, or blended for wash water. Even fuel oil preheat is exact when an All-Sarco job is installed. These savings and many more are available through the Sarco Representative near you. Ask for Catalogs applying to your special conditions.



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COMING EVENTS

NACE—1949 Conferenec of the National Association of Corrosion Engineers to be held in Cincinnati April 11-14. Headquarters:—Netherland-Plaza Hotel, Cincinnati.

WMCE—The Sixth Western Metal Congress and Western Metal Exposition will be held at the Shrine Auditorium, Los Angeles, April 11-15.

MPC—The 11th Annual Meeting of the Midwest Power Conference will be held at the Sherman Hotel in Chicago, April 18, 19, and 20, 1949.

AIEE—1949 Meeting of the American Society of Electrical Engineers, South West District Meeting, Dallas, Baker Hotel, April 19-21; Summer General Meeting, Swampscott, Mass., New Ocean House, June 20-24; Pacific General Meeting, San Francisco, Fairmont Hotel, August 23-26; Midwest General Meeting, Cincinnati, Netherland Plaza Hotel, October 17-21.

ASCE—1949 Meeting of the American Society of Civil Engineers, Spring Meeting, Oklahoma City, April 20-23; Summer Convention, Mexico City, July 13-15; Fall Meeting, Washington, D. C., November 2-4.

The Spring Meeting of the Prime Movers Committee, of the Pennsylvania Electric Association, will be held at the William Penn Hotel, Pittsburgh, May 5 and 6.

ISA—The Fourth Annual Spring Meeting of the Instrument Society of America will be held at the Royal York Hotel, Toronto, Canada, May 12 and 13.

The Tenth Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held at the William Penn Hotel Pittsburgh, October 17, 18, and 19.

NDHA—The 40th Annual Meeting of the National District Heating Assn. will be held at The New Ocean House, Swampscott, Mass., May 24-27.

ASTM—The 52nd Annual Meeting of the American Society of Testing Materials to be held at the Chalfonte-Haddon Hall, Atlantic City, June 27 to July 1.

ASTM—The First National Meeting of the American Society of Testing Materials to be held on the West Coast will be held at the Fairmount Hotel, San Francisco, October 10-14.

Midwest Power Show—The 9th Midwest Engineering and Power Exposition will be held at Navy Pier, Chicago, November 11-16.

The Annual Wisconsin Power Conference and Exposition will be held at the Schroeder Hotel, Milwaukee, June 2, 3, and 4.

WATER CONDITIONING FIRMS JOIN FORCES

ANNOUNCEMENT THAT Elgin Softener Corp., Elgin, Illinois, and Illinois Water Treatment Co., Rockford, Illinois—have joined forces. In commenting upon the new alignment, Chester T. McGill, who heads the Elgin organization, explained that the over-all purpose is to provide a better, more complete water conditioning service at minimum cost to the user.

The management states that through consolidating manufacturing operations, production economies are being accomplished which can be passed on to the user. An important part of the plan is an integration program which will greatly broaden the scope of services available through a nation-wide organization of sales engineers and technical field men with offices in forty principal cities. This will permit close personal attention to be given all phases of water conditioning, including special ion-exchange problems.

Obituaries

DR. WILLIAM MONROE WHITE

DR. WILLIAM MONROE WHITE, 77, retired manager and chief engineer of the Allis-Chalmers hydraulic department, died in Jackson Memorial Hospital, Miami, Fla.

A native of Valley Head, Ala., Dr. White attended the University of Alabama for a year and received a bachelor of science degree from Tulane University. In 1930, Tulane presented him with an honorary doctorate of science.

In 1940, Dr. White received a special Modern Pioneer award made by a distinguished committee of scientists headed by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, for his invention of the Hydraucone draft tube regainer, an improved concentric-type draft tube for improved flow in hydraulic turbine draft tubes.

Dr. White was a member of the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the Franklin Institute, Sigma Xi Society, and the Engineers' Society of Milwaukee.

He was the author of numerous technical papers and was well known on the lecture platform, not only as an authority on hydraulic turbines, but for many lectures on his world wide travels, illustrated by color photographs on which he also became a recognized authority.

OTHMAR K. MARTI

OTHMAR K. MARTI, 57, a consulting engineer for Allis-Chalmers Manufacturing Co., died February 15 after a short illness.

A native of Frick, Switzerland, Mr. Marti attended high school there. He was graduated in 1910 from the Institute of Technology in Zurich with an electrical engineering degree. In 1914 he received a bachelor of science degree from the Polytechnic (State) Institute at Karlsruhe and Berlin, and in 1916 mechanical and electrical engineering degrees from the Polytechnic (Federal) Institute in Zurich.

Mr. Marti wrote extensively for engineering and technical magazines. He was co-author of the book entitled "Mercury Arc Power Rectifier," and contributed the section on rectifiers to the Standard Handbook for Electrical Engineers. He held numerous patents on circuit breakers, controls, transformers, rectifiers, etc.

ELMORE H. SCHIEMANN

ELMORE H. SCHIEMANN, mechanical engineer, associated with Pioneer Service & Engineering Co. Chicago, Ill., for many years, died suddenly February 11, 1949, on a train returning him to Chicago from a business trip to Pueblo, Colo. He was 48 years old, a registered professional engineer in Illinois, Oklahoma, Minnesota, Colorado and California and a member of American Welding Society and American Society for Testing Materials.

DIESEL AND COAL MEN TO WORK TOGETHER ON GAS PROBLEMS

UNUSUAL FEATURE of the recent annual meeting of the Diesel Engine Manufacturers Association in Chicago was the discussion between DEMA and representatives of the coal industry research forces concerning the future gas supply that may be available for dual-fuel engines.

A trend that has developed in recent months in the Diesel engine industry prompted DEMA to invite the representatives of the Bituminous Coal Research, Inc., and of the Battelle Memorial Institute, to be its guests. The trend has arisen from an increasing use of dual-fuel engines, which can burn both oil and gas fuel. The coal industry officials were told that the Diesel industry, having developed the dual-fuel engine, wanted assurance that gas would be available wherever the engines were located.

J. B. Morrow, president of Bituminous Coal Research, Inc., opened the speaking session by giving the background of BCR and its activities. Dr. Harold J. Rose, vice president of BCR and director of its research program, said the program was one of the largest in the country from a standpoint of dollars expended.

Ralph Sherman, assistant director of Battelle, said it had under way an extensive program on gasification of coal, believing gasification was the most economical way to use the nation's coal resources.

That need was emphasized by Carl E. Miller, Battelle's technical advisor, who stated that present-day producers were too big—they must be smaller, portable and less costly.

In the ensuing question-and-answer period, Harlan W. Nelson, supervisor of Battelle's fuels research, said that an economic study of a producer yielding a gas of 150 to 180 Btu per cu ft, indicated that the cost of such gas would be approximately 5.6 cents per therm, with coal at $7.50 per ton.

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YOU get the Hydromatic Single Control Valve as standard equipment on Cochrane Zeolite Water Softeners. . . . This exclusive patented feature, developed by Cochrane engineers, combines, in a single unit, a 4-position valve for service, back wash, brine and rinse, and in addition has 2 stand-by positions.

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Illustrated above is a single-unit manually operated Cochrane HYDROMATIC Zeolite Softener. It is also designed for automatic operation. A small 40-watt motor turns the valve positioner.

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New ENGINEERING BOOKS

Basic Refrigeration and Air Conditioning, by Robert Henderson Emerick. 260 pages; 80 illustrations; 33 tables; size 6 by 9 in.; cloth binding; published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.00.

Here is a somewhat different textbook on this subject and, in our opinion, a very good one. It is designed primarily for those interested in the possibilities of a career in refrigeration and air conditioning and is based on data used in training a large force of various types of tradesmen in this work during World War II. Consequently the subject had to be approached to make the theories and principles understandable to everyone regardless of his formal education. For the student or beginner in the subject, also for the engineer in other fields who wants to gain a basic knowledge of modern practice, it should prove very valuable.

One of its features is the simple, clear style in which it is written, quite informal, with many allusions to well-known phenomena; and simple, though correct, explanations of theories that are usually concealed in a forest of technical verbiage. Another good feature is that the book contains many diagrams of modern equipment, actually encountered in today's plants, phantom views and simple diagrams showing the fundamental principle of operation.

A third good feature is that, in considering a specific phase of any of the work, the author starts by explaining the fundamental principles, gives details of the equipment and then shows the calculations necessary for figuring typical problems that arise in that work, inserting right at that point the necessary tables of data, diagrams of equipment and the like.

One of the most interesting chapters is the last one on making a living in the refrigeration and air conditioning business.

After a short opening chapter giving terms and definitions, the author discusses refrigerants and how they act, refrigeration by direct expansion, by ammonia and brine, and by ammonia absorption. This is followed by a chapter on refrigeration by the steam jet system, another on spray ponds and cooling towers, then discussions of cold storage, ice making and the like.

The last six chapters of the book are devoted primarily to air conditioning; there is a long, detailed chapter on how to calculate a typical air conditioning job, assuming a specific installation and giving all the necessary methods of calculation, tables, curves required in doing it. There is a very good chapter on the heat pump, showing how to figure the cost of using it in comparison with other methods of heating and air conditioning. A trouble-shooter's chart, a bibliography of reference work and an index complete the book.

• • •

Power & Process Steam Engineering, by Douglas Copp. 174 pages; 99 illustrations; 5½ by 9 in.; cloth binding. Published by Longmans, Green and Co., Inc. 55 Fifth Avenue, New York. Price $3.75.

Although this book is based primarily on English practice, it is a most unusual and valuable discussion for industrial power engineers everywhere. It is devoted entirely to the subject of industrial steam power engineering. Every part of the discussion is related directly to the industrial power plant—not the central station.

The reason is that, in Great Britain, coal, the principal source of artificial heat (and one of the country's greatest material assets) is being rapidly dissipated and must be conserved as much as possible. The days of cheapness and apparent plenty, says the author, have passed and all engineers and industrialists must think more and more of economy of heat utilization. This volume has been written to describe the methods and principles that form the basis of various plans for doing this.

What the author does is to bring together data on all methods used in industrial steam power engineering and discuss them with reference only to that activity, even though they may have many other applications in utility engineering or process work.

Chapter V on methods of planning a new power-process steam installation is a typical example of this. We know of few places in the textbooks, even in the United States, where you will find material on planning a new power plant installation in just this form. It is true that Harding, David Moffatt Myers, W. A. Shoudy, Fernald and Orrok, Barnard Ellenwood and Hirshfeld, Morse, Gaffert, MacNaughton—all give something on it, but not in just this way.

The author begins with description of why steam is an efficient vehicle for turning heat into mechanical energy and how industrialists can get that heat out of the steam and use it. Next he discusses methods of simultaneous generation of power and process steam, the optimum of economy. Then come chapters on use of steam for process and heating; generation of power by steam; planning a new installation; choice of steam conditions and steam generating plants; back-pressure and extraction engines and turbines; the improvement of existing installations; maintenance of the efficiency of steam-raising and utilizing plant; and finally electrical principles and maintenance of electrical machinery.

It is exactly these things with which the industrial power plant engineer is primarily concerned. Everybody hears so much these days about the 100,000-kw 1050-F utility turbine generators with reheat that there is a tendency to forget that for every pound of steam generated in a utility plant, there is at least another pound generated in an industrial plant. Furthermore, there are probably from 5 to 10 times as many fairly large industrial steam plants as there are utility plants, to say nothing of all the small installations, all burning fuel primarily to obtain process heat.

The American engineer will have to make due allowance for differences in terminology—i.e. English pass-out turbine = American extraction or bleeder turbine. Also, the book is primarily an outline of the factors to be considered, not a detailed analysis of every factor. But, making these allowances, industrial power engineers will find their own particular problems treated here without reference to those of the utilities. They will find this unusual, stimulating and very helpful. It emphasizes the need for a similar book detailing American industrial power plant techniques.

• • •

Smoke Prevention Association of America, Papers Presented at the 41st Annual Meeting, by various authors. 190 pages; illustrated; size 8½ by 11; paper bound. Published by John Paul Taylor, 520 Pleasant Street, St. Joseph, Michigan. Price $2.00.

Contents of this book range from a discussion of what industry is doing about Pittsburgh smoke to practical suggestions on operation to keep fuel burning equipment smoke free. The papers are by consulting and industrial engineers, smoke inspectors, equipment manufacturers, and others. The membership of the Smoke Prevention Association is made up primarily of smoke inspectors from municipalities.

There are fifteen articles in the publication. Among these are discussions of stack smoke and dust as a community problem and operating pointers on keeping fuel burning equipment smoke free. A paper on two methods of wet scrubbing of gases for reduction of atmospheric pollution, by A. W. Anthony, Jr., is included. This includes data on the new Venturi scrubber described in POWER GENERATION, May 1948.

Other important papers discuss marine practice in oil burning; what industry is doing about Pittsburgh's smoke; dust fall studies; and elimination of flue dust from stoker fired boilers.

• • •

Combustion Engines, by Arthur F. Fraas. 440 pages; 245 illustrations and tables; size 6 by 9 in., cloth binding. Published by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 18, N. Y. Price $5.50.

Designed primarily for the use of engineering college seniors and young engineers in the industry, this book deals with reciprocating engines, problems of combustion, practical thermodynamic analysis, fuel metering and injection, lubrication, and so on. The author, now with the Aeronautical Institute of Technology of Brazil, formerly at Case Institute of Technology at Cleveland, approaches the subject by developing the ideal relationships from elementary theory, and then shows how these are related to satisfactory methods for solving practical engineering problems. Familiarity with college chemistry, physics, thermodynamics, and fluid mechanics is essential to a full understanding of the text.

The book begins with a discussion of engine types and construction, then treats idealized cycles, thermodynamic-calculation methods for combustion-engine cycles, combustion, and cycle analysis.

Following this are chapters on fuel metering and injection; ignition; fuels and lubricants; intake and exhaust manifolds; lubrication; cooling; supercharging; performance analysis. There is a good chapter on the gas turbine, and the book concludes with discussion of engine installations and overhaul and maintenance.

• • •

Waterbury's Handbook of Engineering; Fourth Edition; 386 pages; illustrated; size 3 by 5½ in.; cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York. Price $2.00.

Here is a little handbook of engineering data that actually will go into a vest pocket. It was originally compiled and edited by L. A. Waterbury and this edition has been edited by Professors Reddick of New York University; Lansford of the University of Illinois; Mackey of Cornell University; Higbie, University of Michigan; and Bull, University of Michigan.

It is intended as a reference book for those who have studied, or are studying, the branches of mathematics usually taught in engineering courses. It is not intended as a text and, therefore, does not attempt to prove many of the formulas given. It incorporates a great deal of material from other standard works by permission of the authors and publishers.

It contains, first of all, tables and diagrams of algebraic formulas, trigonometry, mensuration, and analytic geometry.

Then follow tables of differential and integral equations; next come sections on theoretical mechanics and mechanics of materials, including tables of various types of beams, struts and columns, reinforced concrete and the like.

This is followed by tables on mechanics of fluids, including flow in pipes and flow in open channels. The next section is devoted to heat engineering, covering: elements of thermodynamics; properties of perfect gases and real gases; vapors; refrigeration; flow of gases and vapors; and heat transfer. The final section on electrical engineering presents all the fundamental equations and relations, with many diagrams of circuits and connections including data on illuminating engineering, radio and electronics. At the end of the book are complete logarithm tables; logarithms of sines and cosines, tangents and cotangents; natural functions; and properties of saturated water and steam from Keenan & Keyes Steam Tables.

For the engineer who is thoroughly grounded in the various subjects, this little handbook should prove extremely valuable as a pocket reference away from the office where it is not convenient to carry the much more bulky and comprehensive engineering handbooks. It appears to be a very practical and useful little book.

• • •

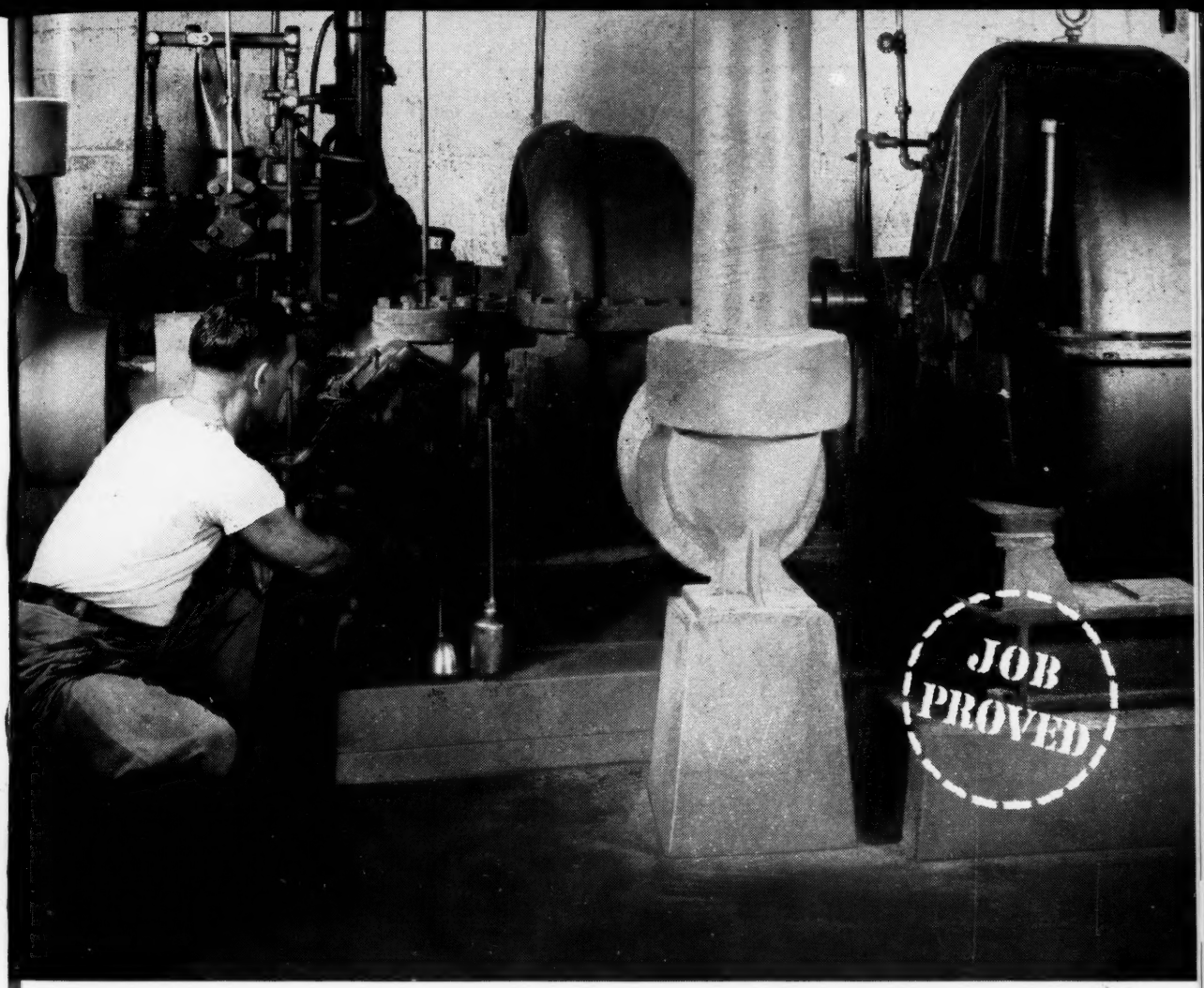
Rotary Valve Engines, by Marcus C. Inman Hunter. 214 pages; illustrated; size 5½ by 8½ in.; cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York. Price $5.00.

Here is the first book to be devoted entirely to the rotary valve—an ingenious device that engineers and inventors have sought to make successfully for over sixty years. The author is a British consulting and research engineer. Among his best known works are the Cheswold car and the Adams 16-cylinder racing boat engine.

In addition to presenting all the technical details of the rotary valve and its use in engines, the book is also a plea for a careful engineering re-examination of the advantages of this valve for many applications.

Whether or not the rotary valve will ever completely replace other kinds of valves is debatable. It does challenge the supremacy of the poppet valve used on the majority of large and small internal combustion engines and the author believes that it will be used far more, in the future, on high-speed engines.

The book begins with a historical foreword; then gives valve definitions and principles of design; discussion of port areas and valve diameters for four-cycle engines; drive gear and general application of the rotary valve to the engine. Chapter V discusses early examples of rotary valves and following chapters discuss semi-rotary sleeve-valve engines; modern rotary-valve systems; the rotol auxiliary generating plant for aircraft; German disk-valve engines; and finally, there is a chapter on claims for the rotary valve, future trend and reflections; and author's conjectures. The book is well indexed.



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Sunvis 900 Oils Still Like New After 3 Years' Service — Gears and Bearings Show No Wear

In October 1945 a paper mill started up a turbine which had been idle during the war. Sunvis 900 Oils were put in the circulating system and the bath-lubricated gear reduction unit. The operating temperature was about 140°F.

Today, nearly three years later, this equipment still runs on Sunvis 900 exclusively. It requires little makeup. The oils go unfiltered and untreated. No sludge has formed.

During the last two summers the equipment stood idle for a few months, exposed to inevitable condensation. Inspected recently, the gears and bearings showed no measurable wear, and were free from rust and corrosion, despite the intermittent operation. The oil is in excellent condition, although never changed.

In all major industries, similar excellent results are being obtained by companies which have adopted Sunvis 900 Oils for preventive maintenance. Sunvis 900 Oils are fortified to resist deterioration and to protect metal parts against rusting and corrosion. These long-lasting, top-quality oils *keep productive machinery running longer*. They can do the same for you. Call your nearest Sun Office, or—for a copy of the illustrated booklet "Sunvis 900 Oils"—write Department PN-4

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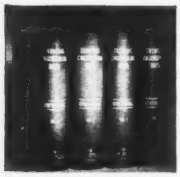

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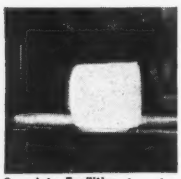

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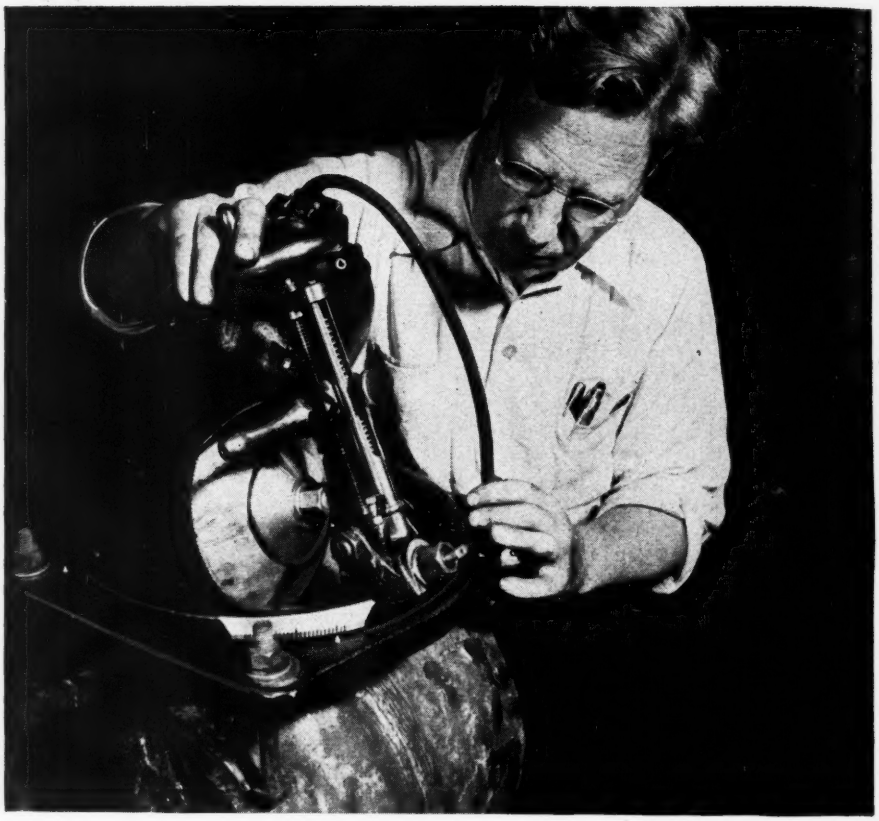

Gouging that pays off!

GOUGING has an unpleasant connotation in most lines of business. But when it comes to power piping, "gouging" means longer life and better service from pipe because it shows you what you can't see by just peering at a pipe installation or scrutinizing a manufacturer's stamp.

Let's take a peek at this thing you can't see. It all starts out with the familiar weld-prober shown above. This portable piece of equipment gouges out boat-shaped samples from pipe that is actually in service position. The holes it leaves are carefully refilled by welding and service quickly resumed.

It's what happens to these samples that is important; that's one of the major reasons Kellogg power piping is held in such high repute.

For some time these gouged-out samples have been used in an exhaustive study of the eccentricities of graphitization – the metal disease that attacks high temperature and high pressure piping during service life and seriously impairs its original strength.

There are some seventy-five talented technicians actively engaged in metallurgical study at Kellogg's Jersey City Laboratories. One of their principal programs is the study of graphitization. Much data has been gathered . . . much more will be forthcoming. Everything that is already known goes toward providing better power piping.

Such invisible technical advancement is duplicated throughout every phase of power piping work—from the use of exclusive stress analyzing equipment to the testing of welds on the actual installation site. It is the important advantage you can't see when you buy power piping from M. W. Kellogg.

To master temperature, pressure and chemicals use

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process equipment

VESSELS • EXCHANGERS • CONDENSERS • HIGH PRESSURE AND HIGH TEMPERATURE POWER PIPING PROCESS PIPING • FORGED AND WELDED FITTINGS . . . IN ALL STEELS, ALLOYS OR SPECIAL COMBINATIONS

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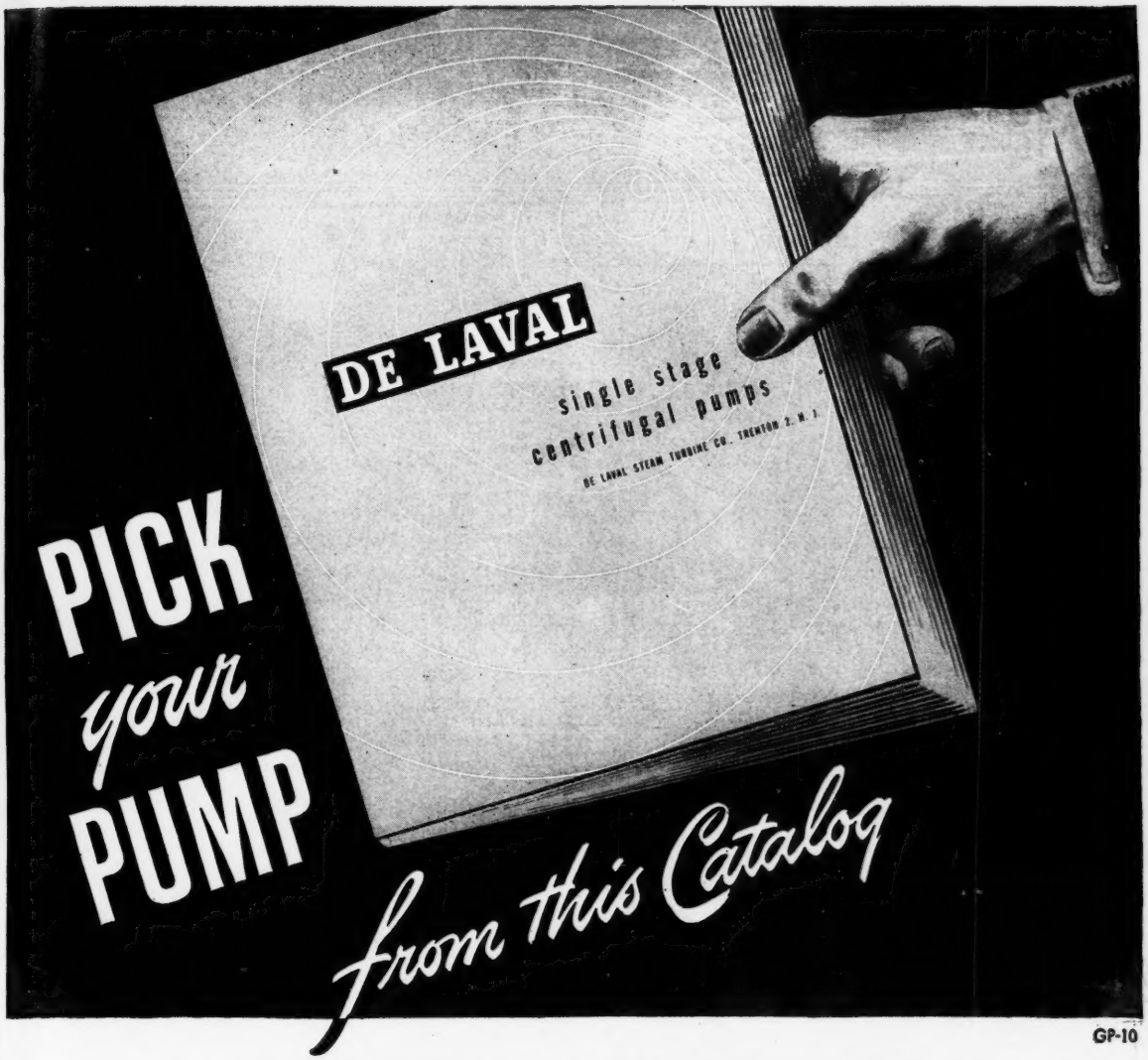


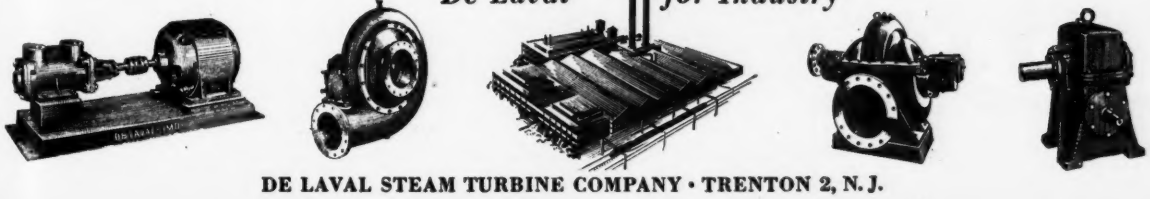
GP-10

COMPLETE WITH RATING TABLES AND DIMENSIONS

The text explains and illustrates features of design that you should look for when buying a pump. The simplified rating tables list pump and motor sizes for delivery and head requirements ranging from 150 gpm and 30′ head to 5000 gpm and 250′ head. The dimension drawings provide all information necessary for preliminary installation layouts. Ask for catalog GP-10.

DE LAVAL

De Laval for Industry



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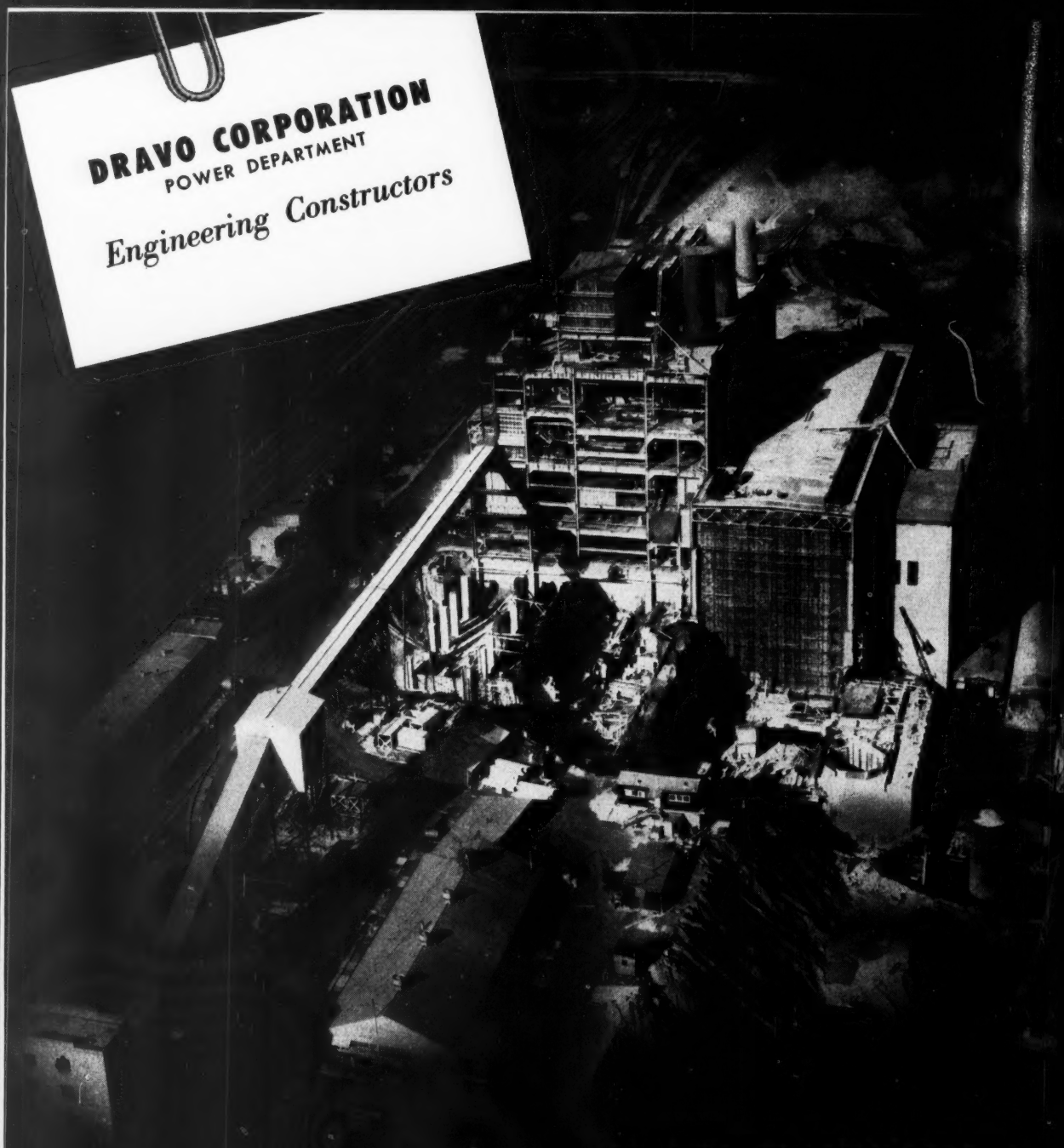

DUQUESNE LIGHT COMPANY'S Frank R. Phillips Power Station at Wireton, Pa. Units 2 and 3, now being constructed by Dravo, will more than triple the original 75,000 kw capacity of this key station serving the Pittsburgh area.

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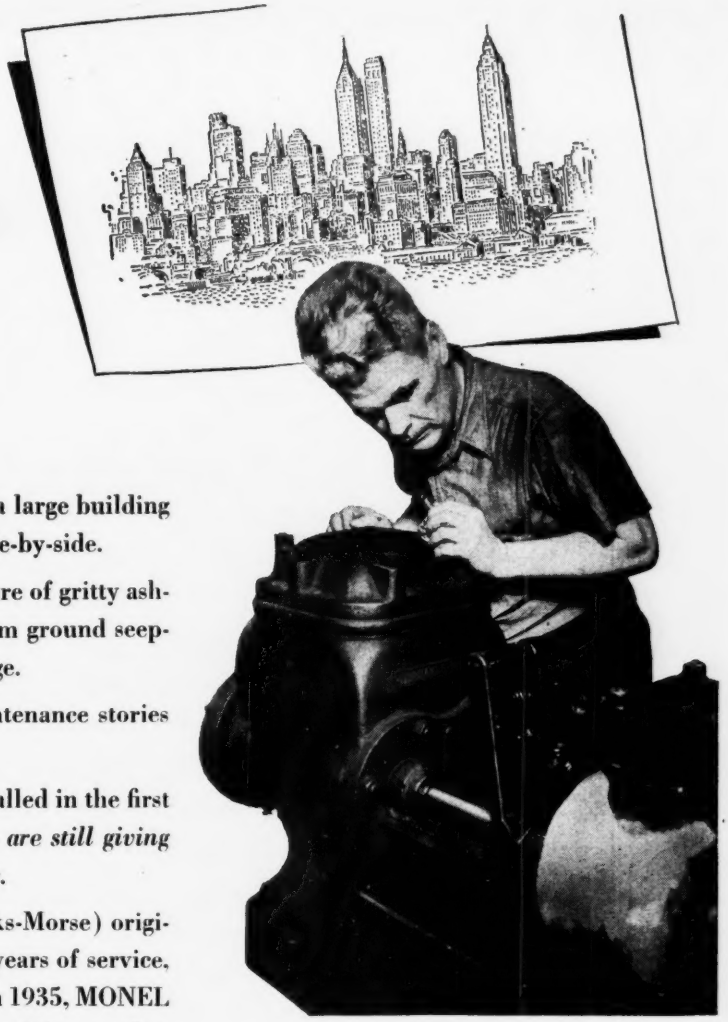
30-YEAR OLD MONEL PUMP RODS OUTLAST OTHERS 9 TO 1



In the basement power plant of a large building in New York City, two pumps work side-by-side.

Both pumps handle a sump mixture of gritty ash-quenching waters, polluted waters from ground seepage, corrosive waters from coal drainage.

Identical service...but their maintenance stories are far from identical!

In 1918, MONEL* rods were installed in the first pump, a Fairbanks-Morse. These *rods are still giving perfect service today, thirty years later.*

The second pump (not a Fairbanks-Morse) originally had bronze rods. In the first ten years of service, these rods were replaced *three times.* In 1935, MONEL rods were installed. They have been giving perfect service ever since...*for thirteen years.*

The chief engineer says of the MONEL rods: "In my opinion, they will last as long as the pumps."

This is a story worth remembering next time you need pump rods, new or replacement. For when you specify MONEL, you get a "task metal"...one that is rustproof, corrosion-resistant, stronger than structural steel, hard, tough, yet readily machinable.

If your problem involves corrosion or excessive wear of working parts, why not write to Bob Johnson of INCO? He may be able to help you find a solution.

*Reg. U.S. Pat. Off.

Fairbanks-Morse sump pump. The 30-year old MONEL pump rods have never been replaced or reground, show very little wear, and seldom need repacking.

MONEL

...FOR MINIMUM MAINTENANCE

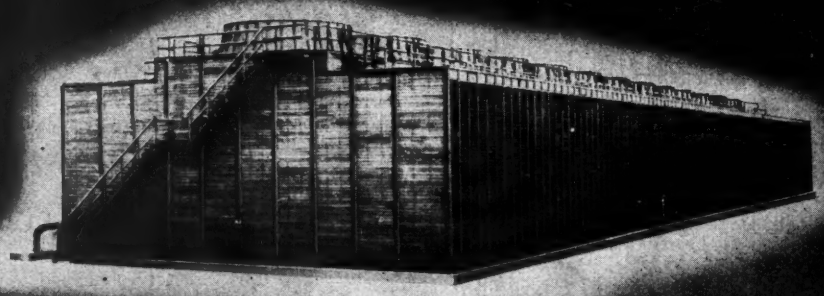
EMBLEM OF SERVICE

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

Specify MARLEY Double-Flow



FOR AN ENGINEERED TOWER STRUCTURE

Every Double-Flow Cooling Tower is structurally sound . . . able to give twenty-four hour a day, year around service.

Double-Flow cooling towers have been subjected, during the past decade, to hurricane, earthquake, corrosive atmosphere and other similar tests without suffering a single loss. Here's why:

LUMBER . . . only the finest HEART QUALITY REDWOOD is used. All structural members are properly sized and are free from sapwood that is subject to fungus and insect attack.

HARDWARE . . . heavy bolts are used throughout with ring connectors added at critical joints . . . no nails are used to bear any structural load.

MECHANICAL EQUIPMENT SUPPORT . . . massive, corrosion-free wood crossbeams are used to support the mechanical equipment. Diagonal bracing in this area gives added strength.

COLUMNS . . . vertical columns placed on a maximum of six foot centers. Louver posts are machined to accommodate the continual expanding and contracting slip-fit louvers.

BRACING . . . transverse and longitudinal bracing extending from each six foot height to the bottom of the tower.

Each joint and every detail, as well as the major members of a standard MARLEY DOUBLE-FLOW Cooling Tower are guaranteed against a 30-pound wind. The low, wide design of the Double-Flow gives unusual stability.

To be sure YOUR new cooling tower is STRUCTURALLY SOUND, Specify MARLEY DOUBLE-FLOW!

Ask for a Marley Factory-Trained APPLICATION ENGINEER to tell you more about the MARLEY-DOUBLE-FLOW and its ENGINEERED STRUCTURE. He'll be glad to help you solve your water cooling problems. No cost

MARLEY COOLING TOWERS

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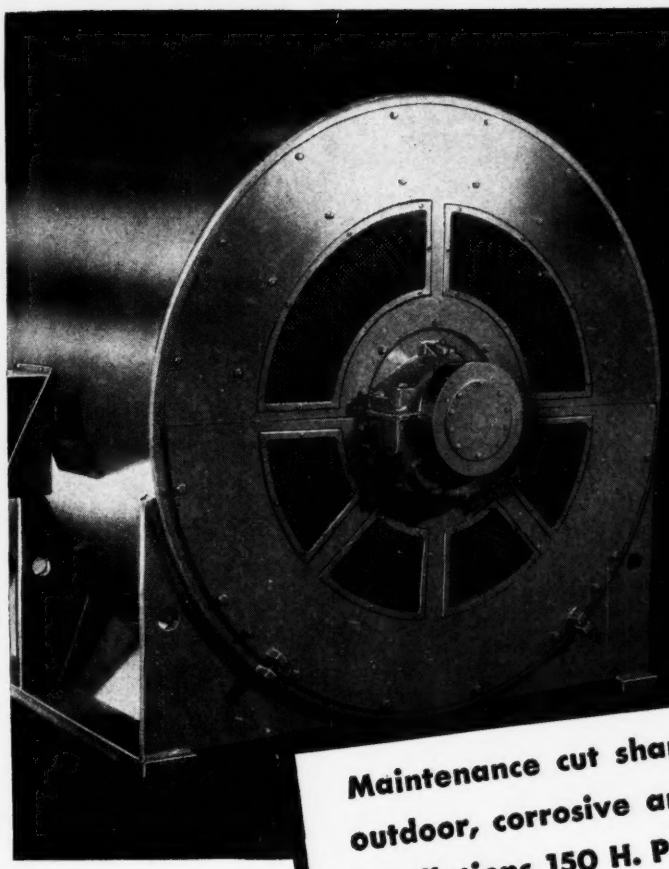

NEW

TUBE-TYPE TOTALLY-ENCLOSED FAN-COOLED

Motors

Maintenance cut sharply on outdoor, corrosive and dirty installations 150 H. P. and up

THE UNIQUE COOLING SYSTEM of the new Allis-Chalmers tube-type, totally-enclosed, fan-cooled motor reduces maintenance to a point never before reached in totally-enclosed motor design. Tubes surround the stator. Internal fans circulate air within the motor to transfer heat to the tubes. An external fan moves outside air through the tubes to remove heat quickly and effectively.

Maintenance Materially Reduced

The new Allis-Chalmers tube-type motor rarely needs cleaning because tubes are straight, the air passages unrestricted, and the cooling air flows at sufficient speed to carry foreign matter out with it. Should unusually dirty air conditions make cleaning desirable, tubes can be swabbed out quickly and easily. This new motor can be installed indoors or out in any atmosphere.

Cooling Efficiency Proved

Three years of successful field operation back up this new motor. For information, on how it can mean lower costs for you, contact your nearest A-C District Office or write for bulletins 51R7149 and 05B7150.

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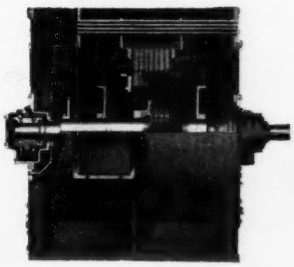

HOW TUBE-TYPE COOLING SYSTEM SAVES YOU MONEY ON MAINTENANCE

1. **LARGE HEAT TRANSFER AREA** of tubes plus efficient air flow removes heat quickly.
2. **STRAIGHT TUBES** do not normally clog or collect moisture and foreign matter.
3. **INTERNAL FANS** keep enclosed air constantly circulating, assuring even cooling and fast heat dispersal.
4. **EXTERNAL FAN** blows air through tubes to remove heat quickly and efficiently. Air speed keeps tubes clean.
5. **ALL ELECTRICAL PARTS ARE ENCLOSED:** Dirt cannot enter.

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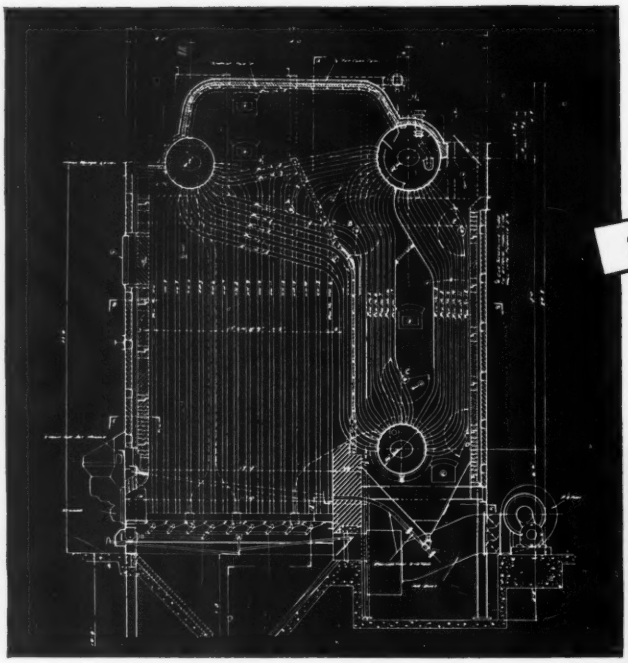
ALLIS-CHALMERS

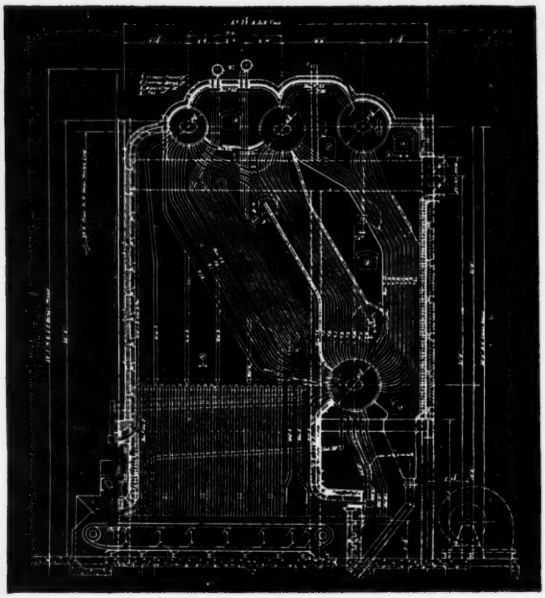
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY Vogt

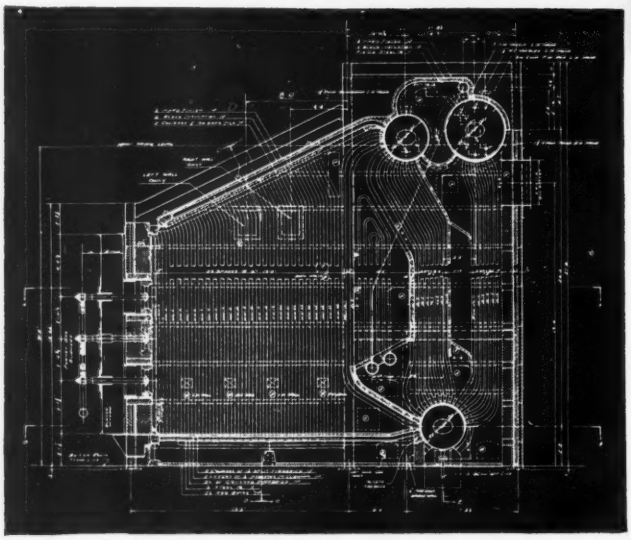
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

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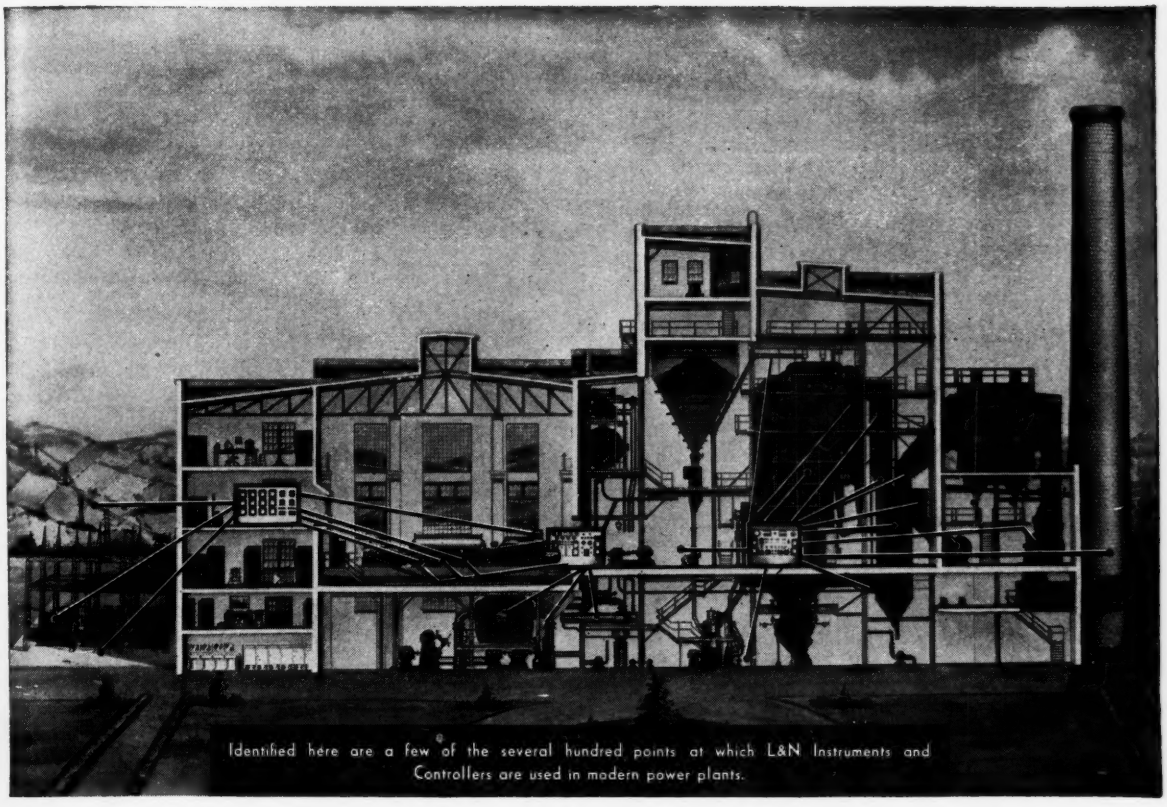

Identified here are a few of the several hundred points at which L&N Instruments and Controllers are used in modern power plants.

From Fuel Bunker To Tie Line — L&N Instruments Help Power Output

From fuel bunker to switch yard and tie line, L&N offers a completeness of instrumentation unobtainable from any other single source. Recording and controlling needs may originate at both ends of the turbo-generator shaft, or anywhere along its length, and be handled by L&N instruments with outstanding ease and success.

At the steam end of the shaft are Metermax Combustion Control; Micromax Superheat Control; Micromax and/or Speedomax Recorders which give coordinated strip-chart records of all boiler and mill temperatures; recording of CO_2, smoke density, steam purity and pH.

Turbine Board Instruments

In the turbine room are Micromax Strip-Chart Recorders for temperatures of the feed water and condensate cycle; condenser temperatures; bearing and oil temperatures; electrolytic conductivity, and flow in connection with the Centrimax Flowmeter.

At the electric end of the shaft are Micromax and/or Speedomax Strip-Chart Recorders for temperatures in bearings, stators, fields, transformers and cables; for frequency; for remote voltage. L&N Load-Frequency Control and Load Telemetering apply to either the station, or system, or both.

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The trend to complete, central-control boards and cubicles has always been advocated by L&N. Highly specialized engineering and production facilities give you equipment arranged for proper operation. It reaches you assembled, wired and tested; ready for installation. You save heavily in your own time and responsibilities.

Further information will be sent on request. Address Leeds & Northrup Company, 4973 Stenton Avenue, Philadelphia 44, Pennsylvania.

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A New

EVERLASTING

DUPLEX UNIT

for dual safety in blow-off service

Here's an EVERLASTING valve team that's sure of a cordial reception by engineers!

This new EVERLASTING Duplex Blow-off Unit provides dual safety—plus extreme durability—obtained by coordinating the respective merits of two highly efficient EVERLASTING Blow-off Valves.

✓ *Check these combined advantages*

This is the new Everlasting Rack & Screw Valve — screwed or flanged, slow-opening type —*the sealing valve*

The Sealing Valve

✓ Unimpeded straight-through flow — at full pipeline capacity

✓ Self-grinding action of disc across seat keeps valve constantly self-lapped to microscopic precision—a drop-tight seal always assured

✓ Non-wedge construction — valve cannot jam or stick

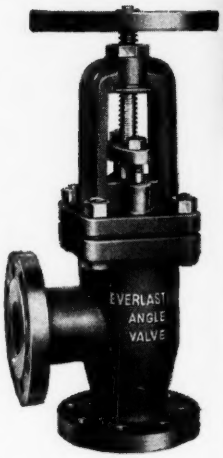
The Blowing Valve

✓ Built stoutly — to withstand shock of the blow-off force

✓ Built of tough materials — to resist erosion and abrasive action of solids in blow-off water

✓ Built without pockets — to prevent lodgement of solids

✓ Built to seal drop-tight — and stay that way



This is the Everlasting Angle Valve—*for taking the blowing force*

In dual operation these EVERLASTING Valves have what it takes to render dual safety in blow-off service . . . and they keep on doing it! And for ease of operation, positive blow-off action, drop tight seal, dependability and long life, this new EVERLASTING Duplex Blow-off Unit is unsurpassed. It has already set new standards of performance in blow-off service!

These valves fully meet all boiler blow-off code requirements. Either valve available separately.

Ask your distributor — or write directly to us—*for complete information.* EV-318

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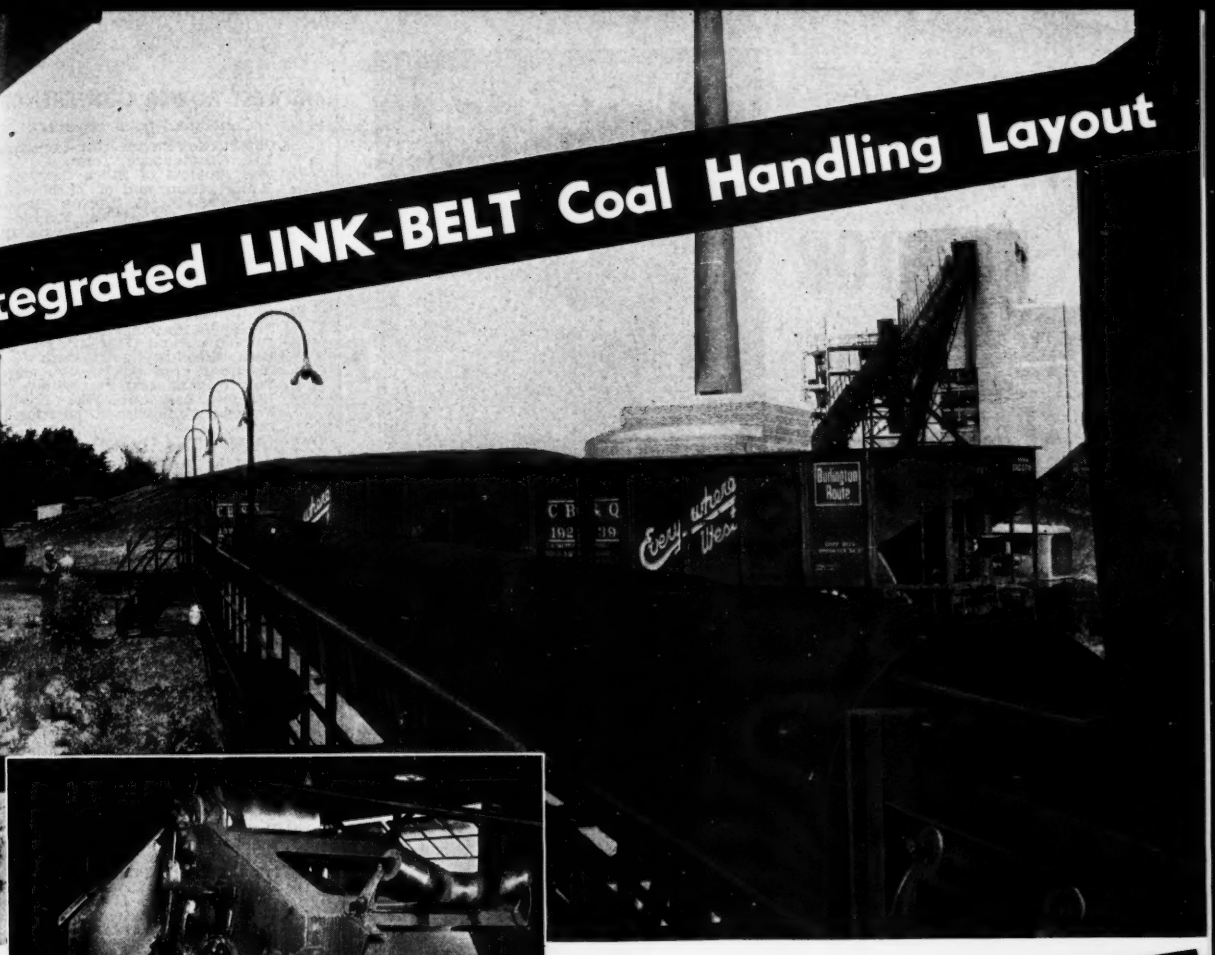
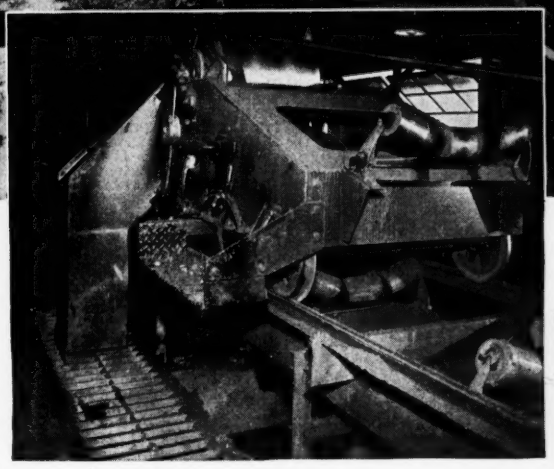
Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF.

EVERLASTING VALVES give "everlasting" service!

Integrated LINK-BELT Coal Handling Layout





at Interstate Power Co. Clinton, Iowa

Four-way flexibility, along with rock-bottom handling costs, is provided by the coal conveyor system installed by Link-Belt at the Interstate Power Company at Clinton, Iowa.

Integrated from standardized types of equipment, this layout receives coal from either railroad cars or from river barges and delivers it to ground storage or to boiler room bunkers as desired. The system also reclaims coal from ground storage to conveyor in connection with a scraper.

This equipment consists of reciprocating feeders, belt conveyors and a self-propelled traveling tripper for distributing coal to the bunkers. A feature of this installation is the use of hood-type corrugated metal housing for the belt conveyors.

Hardly ever are two handling jobs the same. But whatever the job calls for, Link-Belt has the experience to design the layout and the equipment to make the most satisfactory operation. Let us discuss your problem with you.

11,293

TYPES OF LINK-BELT CONVEYING MACHINERY

- Belt Conveyors
- Screw Conveyors
- Bulk-Flo Conveyors
- Chain Conveyors
- Trolley Conveyors
- Apron Conveyors
- Oscillating Conveyors
- Flight Conveyors
- Bucket Elevators
- Bucket Carriers

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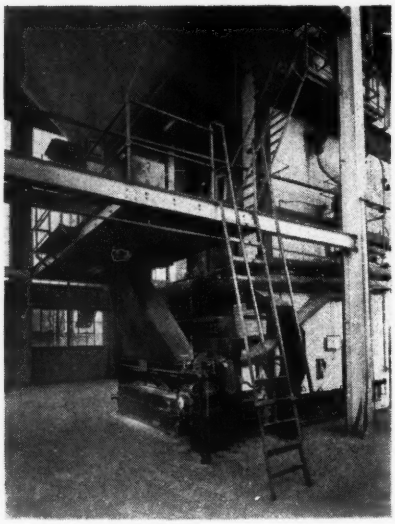
LINK-BELT

CONVEYING MACHINERY
"THE COMPLETE LINE"

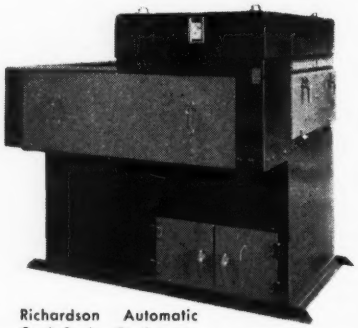
TWO WAYS TO STOP COAL WASTE



Installation at mid-western Municipal lighting plant showing Richardson Coal Gate, Coal Scale and "Monorate" Non-Segregating Distributor.

1

RICHARDSON COAL SCALES: One over each boiler automatically gives you a record of coal consumption, by the hour, shift, day, week or month, in stoker or pulverizer firing. You spot inefficient steaming right away, *before* you start paying invisible bills for wasted coal.



Richardson Automatic Coal Scale, Stationary, Floor Mounted Style.

2

RICHARDSON "MONORATE" DISTRIBUTORS: An original Richardson development* which absolutely stops coal segregation in stoker-fired installations. The "Monorate" is just what its name implies—the curved top plate, developed in theory and proven in practice, causes *all* the coal, both lumps and fines, to descend at the same rate so there is no tendency for lumps to separate. You get the same mix across your stoker hopper as you had at the bunker outlet so that most efficient combustion is assured.

*Patent Pending No. 2,258,516

Richardson "Monorate" Distributor Showing Patented Design of Top Plate Which Keeps Lumps and Fines from Separating.

For further details on Richardson Coal Scales, write for Bulletin No. 1143, and at the same time ask for the new Richardson "Monorate" Bulletin No. 1349-G.

A COMPLETE RICHARDSON INSTALLATION: Leakproof **Gate** from the bunker; flexible **Inlet** to scale; **Automatic Coal Scale**; **"Monorate" Non-Segregating Distributor** to stoker; or down-take **Chute** to pulverizer.

RICHARDSON SCALE COMPANY, Clifton, N. J.

ATLANTA • BOSTON • BUFFALO • CHICAGO • MINNEAPOLIS • WICHITA

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5314

MIDWEST POWER CONFERENCE

(Continued from page 94)

Combustion Engineering-Superheater, Inc., Chattanooga, Tenn.

(b) The Problem of Silica Carryover in Boiler Steam, and of Turbine Blade Deposits. F. G. Straub, Research Professor of Chemical Engineering, University of Illinois, Urbana, Ill.

(c) Steam Contamination Experience on the American Gas and Electric Company's System. W. L. Webb, Mechanical Engineering Division, American Gas and Electric Service Corp., N. Y.

(d) High Speed Motion Picture Study of Steam Formation Phenomena. L. O. Gunderson and C. M. Bodach, Dearborn Chemical Co., Chicago.

(e) Diagnosis of Carryover Problems by Proper Plant Test Procedures. J. A. Holmes, Assistant Vice President, National Aluminate Corporation, Chicago.

10:30 A.M. The Heat Pump. Chairman: C. M. Burnam, Jr., President, Illinois Chapter, American Society of Heating and Ventilating Engineers.

(a) Some Aspects of the Soil Problem in Connection with Heat Pump Buried Coil Design. Donald M. Vestal, Jr., Project Supervisor, Reverse Cycle Heating Project, Texas A. & M. Research Foundation, College Station, Texas.

(b) Controlling the Heat Pump. F. R. Ellenberger, Remote Equipment Engineering Division, Air Conditioning Department, General Electric Co., Bloomfield, N. J.

10:30 A.M. Industrial Applications. Chairman: T. A. Abbott, Chairman, Industrial Group, Chicago Section, A.I.E.E.

(Sponsored and Arranged by Industrial Group, Chicago Section, A.I.E.E.)

(a) Developments in Industrial Distribution Systems. H. B. Thacker, Central Station Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

(b) Distribution Problems Caused by Resistance Welding Loads. H. Watson Tietze, Senior Engineer, Electric Distribution Dept., Public Service Electric and Gas Co., Newark, N. J.

10:30 A.M. Symposium on Steam Contamination, Cont'd.

12:15 P.M. Joint Luncheon with W.S.E. Chairman: L. E. Grinter, Chairman, Civic Committee, Western Society of Engineers.

(Sponsored and Arranged by Civic Committee of W.S.E.)

Speaker: R. A. Stipes, Jr., President, Illinois Chamber of Commerce. "Engineers Can Influence Civic Affairs."

2:00 P.M. Feedwater Treatment No. 3. Chairman: R. C. Porter, University of Michigan.

(a) Problems Encountered in the Treatment of Cooling Tower Water For the Prevention of Incrustation and Corrosion. E. C. Hosbach, Power Engineer, The Texas Co., Lockport, Ill.

(b) Problems in the Treatment of Cooling Water in Industrial Plants. L. D. Betz, General Manager, W. H. & L. D. Betz, Chemical Engineers, Philadelphia, Pa.

2:00 P.M. Diesel Power. Chairman: W. P. Green, Illinois Institute of Technology.

(a) Two Cycle Dual Fuel Engines. L. D. Thompson, Superintendent, Experimental Division, Fairbanks Morse & Co., Beloit, Wis.

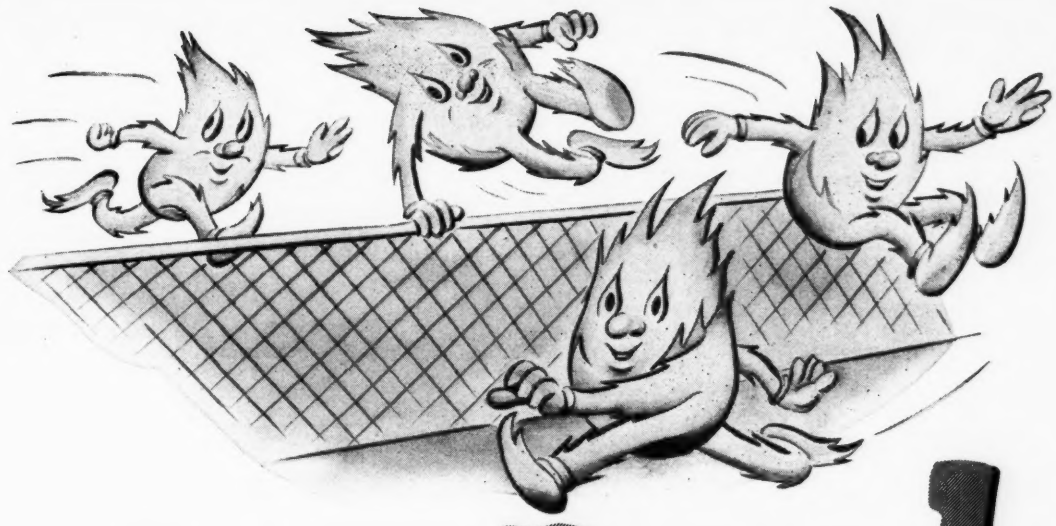
(b) Dual Fuel Engine Design. George Steven, Executive Engineer, Worthington Pump and Machinery Co., Buffalo, N. Y.

(c) Dual Fuel Engine Performance and Economics. Ralph L. Boyer, Vice President and Chief Engineer, The Cooper-Bessemer Corp., Mt. Vernon, Ohio.

2:00 P.M. Electrical Sales. Chairman: R. G. Raymond, General Sales Manager, Commonwealth Edison Co., Chicago.

(a) Television. Fred Compton, General Sales Manager, Detroit Edison Co., Detroit, Michigan.

(b) Promotional Sales Plans for 1949 of The Commercial Section of the Edison Electric Institute. Harry Restof-



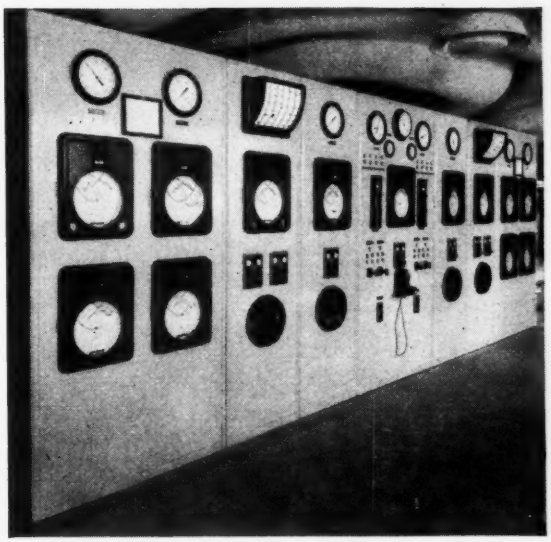
Btu's go a.w.o.l.

Every fuel has a large percentage of Btu's ready to "go over the fence". They do no work. They produce no power. The more you can keep on the job—the lower your power costs will be. And that is exactly what the Bailey co-ordinated boiler control system can do for you.

It reduces fuel consumption per pound of steam generated. Combustion, feed water, steam temperature, heater levels, pump speeds and all other factors are co-ordinated—automatically controlled. With Bailey Controls safety of operation is increased—continuity of service is improved. You convert the maximum number of Btu's into power. You get full efficiency from your boiler.

Many Bailey co-ordinated boiler control systems have paid for themselves in fuel saved in less than one year. All do not return their original cost as quickly as this. But the quick way to find out how Bailey boiler control will work for you is to talk to one of our Engineers. Bailey co-ordinated boiler control is not a package unit. Each must be engineered to the specific job.

If you are looking for low cost power, it will pay you to call our nearest office.



These Bailey Controls help operators to prevent Btu's from going a. w. o. l. in an Oil Refinery.

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Controls for Steam Plants

COMBUSTION • FEED WATER • TEMPERATURE
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HOW YOU SAVE,

Getting Drier Compressed Air

● Direct saving in the cost of cooling water saves the price of the Niagara Aero After Cooler (for compressed air or gas) in less than two years.

Extra, for no cost, the drier air gives you a better operation and lower costs in the use of all air-operated tools and machines, paint spraying, sand blasting or moisture-free air cleaning. Water saving also means less expense for piping, pumping, water treatment and water disposal, or you get the use of water elsewhere in your plant where it may be badly needed.

Niagara Aero After Cooler assures all these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air thru a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter by the Niagara Balanced Wet Bulb Control.

Write for complete information; ask for Bulletin No. 98

NIAGARA BLOWER COMPANY

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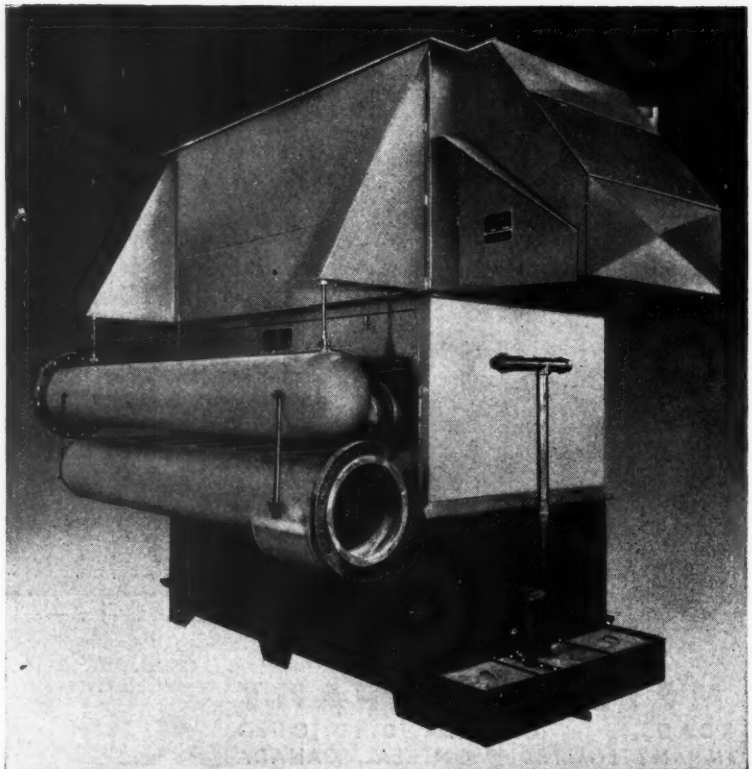

INDUSTRIAL COOLING HEATING • DRYING

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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

ski, General Sales Manager, West Penn Power Co., Pittsburgh, Pa.

3:30 P.M. Gas Turbines. Chairman: J. T. Rettaliata, Illinois Institute of Technology.

(a) Some of the Problems Involved in the Coal Burning Gas Turbine Locomotive. C. K. Steins, Mechanical Engineer, Pennsylvania Railroad.

(b) Design of a Locomotive Gas Turbine. W. B. Tucker, Turbo-Power Development, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

(c) Water Spray Injection of an Axial Flow Compressor. I. T. Wetzel, Lecturer in Mechanical Engineering and B. H. Jennings, Professor and Chairman of the Department of Mechanical Engineering, Northwestern Technological Institute.

3:30 P.M. Electronics Applications. Chairman: A. H. Wing, Chairman, Electronics Group, Chicago Section, A.I.E.E.

(Sponsored and arranged by Electronics Group, Chicago Section, A.I.E.E.)

(a) Electronics in the Public Utilities Field. W. M. Kiefer, Commonwealth Edison Co., Chicago.

(b) Electronics in Industry. G. M. Chute, Application Engineer, General Electric Co., Detroit, Mich.

TURBINE OIL SYSTEMS

(Continued from page 61)

nected to the tank at A, Fig. 7, so as to remove the contaminants that have settled out of the oil. A sight overflow with a vent to atmosphere should be installed at the oil level of the tank and ahead of the oil conditioning equipment, as shown in Fig. 8. Where the oil tank is equipped with an exhauster blower and maintains a few inches vacuum in the lubricating system, the vent pipe should be returned to the tank above the oil level. Seven to ten per cent of the oil should be by-passed through the oil conditioning system per hour. The oil should be returned to the tank below the oil level and at a distance from the take-off.

Following are some of the types of oil conditioning equipment in use today:—centrifuges, bag, cartridge and waste packed filters; blotter presses; water washing equipment and clay filters.

Water Washing Equipment

Water washing equipment, used in conjunction with a centrifuge or bag type filter, has been in successful use for years in a number of installations where conventional turbine oils have been used. Water washing of rust- and oxidation-inhibited oils is not recommended, since experience indicates such practice may remove the inhibitors from the oil. The only exception to this recommendation is where a water-soluble corrosive material is entering the lubricating system.

Clay Filters

Clay filters have been used successfully on installations with conventional oils. They remove the decomposed products, as well as other foreign materials. Experience indicates that, if the acid number of the oil is maintained at too low a value,

Guard your costly boilers with Reliance Safety Equipment

Reliance EYE-HYE gives you high visibility for remote water gage reading

For main boilers or any liquid containing vessels, EYE-HYE *is the original trouble-free gage for dependable remote supervision.*

Single or double gage assemblies...alarm water columns...help you to operate efficiently, avoid water level accidents and dead-loss outage

YOU CAN DEPEND on Reliance Water Columns and Gages for completely satisfactory service on any pressure. Correct equipment is available for various ratings and applications. Here's a typical example of Reliance Equipment properly selected to meet different requirements in the same power plant operating at more than 450 psi—at the Ottawa Silica Company, Ottawa, Illinois.

Left hand column illustrates a single water gage assembly; right hand, a twin gage assembly. Both columns, of the high and low alarm type, are forged steel, trimmed with forged steel Reliance Gage Valves, Water Gage Inserts and Gage Cocks. Gages have Reliance Gage Illuminators and direct vision hoods.

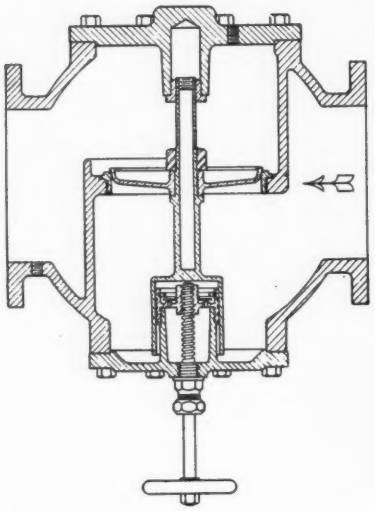
Reliance specializes in high pressure twin gage assemblies—supplies gage connections located at any angle of separation from 90° to 180°, to your specification. Consulting engineers and power men everywhere know Reliance dependability and low maintenance requirements. Ask your consultant or contact the factory for further information.

BOILER SAFETY DEVICES since 1884

Reliance®

THE RELIANCE GAUGE COLUMN CO. • 5902 CARNEGIE AVENUE • CLEVELAND 3, OHIO

CONDENSER RELIEF VALVES



A DAVIS Specialty!

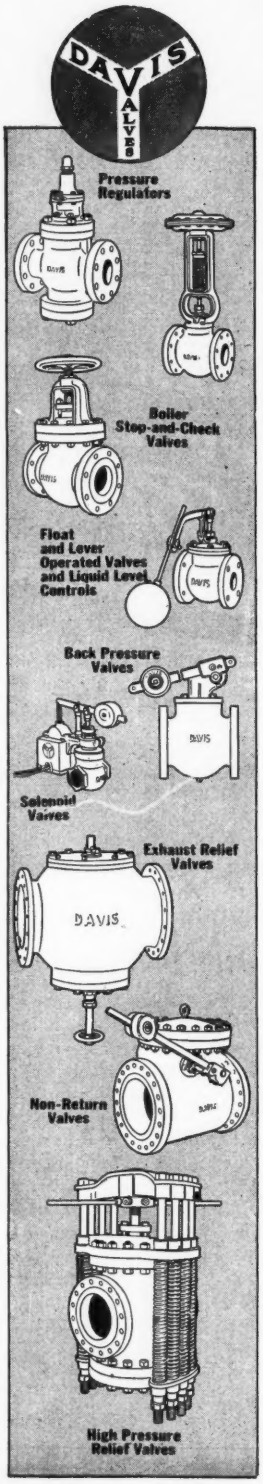
DAVIS specializes in building atmospheric exhaust relief valves to meet the modern needs of power plants for protective equipment. The Davis No. 110 Relief Valve, shown in cross-section above, is one of the several widely-used Davis designs that give engineers what they want for condenser protection.

No. 110 features a quick opening and cushioned closing action. The bronze-to-bronze-contact valve is water-sealed through inlet and overflow pipe connections in the body. It holds tight under high vacuum to prevent air infiltration into the condenser and relieves to atmosphere at a fraction of a pound pressure when for any reason the vacuum is lost. Shown here with hand lift at bottom, it is also available with hydraulic lift.

The Davis line of exhaust relief valves is complete. Sizes from 6" to 48". Horizontal, vertical, or angle body patterns. For detailed information, ask for Bulletin No. 101A.

No. 110 Exhaust Relief Valve

Left. — Davis has brought the atmospheric relief valve to a high point of perfection, with a combination of engineering features not found elsewhere.



DAVIS REGULATOR CO.

Representatives in All Principal Cities

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rusting may take place if and when water enters the lubricating system. It is recommended that where clay filters are used, the acid number be kept at approximately 0.2 or more in order to properly protect ferrous metals bathed by the oil from rusting.

Clay filters should not be used with rust- and oxidation-inhibited oils, since experience indicates that such filters will remove the rust inhibitor and some types of oxidation inhibitors from the oil.

Other Type of Conditioning Equipment

Centrifuges, blotter presses, and waste, cartridge and bag type filters, which have not been activated, are being used successfully with both conventional and inhibited oils.

Some installations are being provided with a "polishing filter" for removal of microscopic particles of dust, fly ash, sand, and the like, down to one micron in size. It will also remove any moisture haze or cloud if present in the oil. This filter should be of definite value when starting up a new turbine and also of continuous value on installations where dust is in the atmosphere.

Preparation of a New Lubricating Equipment

There have been definite improvements by the manufacturers in the preparation of the lubricating systems of industrial turbines during the past few years.

Piping:—After fabrication into sections for subsequent assembly, all piping is cleaned by a suitable pickling process. It is dried and immediately coated with a rust-preventive compound. The pickling process removes all mill scale, grease, sand, rust.

After test in the factory, the piping is cleaned and again coated with the rust-preventive compound.

The ends of the piping are sealed off so that it can be shipped and assembled in the customer's plant free of rust and dirt.

Bearing Brackets, Pump Casing, etc., in Oiling System:—The parts are thoroughly cleaned of scale and core sand. After test, they are cleaned and slushed so as to remain free from rust during shipping and installation in the customer's plant. The flushing compounds used are oil soluble.

Oil Tanks:—The fabricated oil tanks and covers are thoroughly cleaned of all mill scale, grit, and dirt and then solvent-cleaned to remove oil or grease. Immediately after cleaning, they are painted with oil and water-resistant paint.

After test, the tank is again cleaned and if surfaces have become exposed, it is repainted before shipment.

The care used by the manufacturer in preparing the parts of the lubricating system insures that the

He's not on the Iowa Power and Light Co. payroll, but...

Chris Kirn of American Blower is working for the Iowa Power and Light Co. in the picture above.

Here, he is laying out on a sheet of steel another American Blower Type ST Fly Ash Precipitator ordered by the Iowa Power and Light Co.

He knows his job through more than 50 years' experience. He knows the Iowa Power and Light Co. because he has performed this task on their orders and re-orders of American Blower Equipment over the years.

As this job moves to completion, other American Blower skilled craftsmen, each experienced in his task, will check at every stage of construction to make sure that Iowa Power and Light Co. receives a job that's right in every respect.

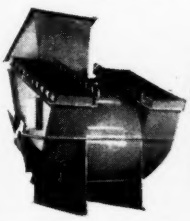
This careful attention to detail is still another reason why America's leading public utilities order and re-order American Blower mechanical draft equipment, fly ash precipitators, Gýrol Fluid Drive for boiler feed pumps and fan control equipment.

They know that the skill and effort men like Chris Kirn put into their jobs, pay off in longer equipment life, greater dependability and increased overall power plant efficiency.

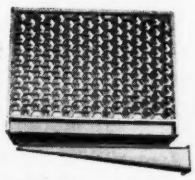
AMERICAN BLOWER CORPORATION, DETROIT 32, MICH.

CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

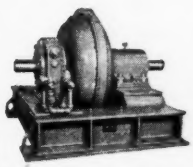
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION



HS and Sirocco Fans for forced or induced draft in all types of power plants.



ST Fly Ash Precipitators—especially for power plants burning pulverized fuel.



Type VS Gýrol Fluid Drive—for adjustable speed control of mechanical draft fans.

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DARTS close tight-stay tight

because of the GROUND BALL JOINT

A TRUE BALL JOINT ... spherical-ground to form wide, true-bearing surfaces ... makes Darts drop-tight, leak-proof. Darts always give a snug fit without excessive wrenching.

BRONZE-TO-BRONZE SEATS ... are extra-wide to give widest possible bearing surface. And each seat is precision-ground to lock the leaks.

EXTRA-HEAVY SHOULDERS ... shrug off wrench abuse and strains. An important feature that gives Darts a longer life.

PRACTICALLY INDESTRUCTIBLE ... body and nut of air-refined, high-test malleable iron. No wonder Darts last longer ... can be used again and again.

See your supplier today for the *longer-life union by Dart* ... first choice for more than fifty years.

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UNIONS

customer will receive it in good condition.

The design of pedestals, piping, and tanks is such that everything drains back to the "V" in the bottom of the main oil tank. There are no "low spots" in which dirt can accumulate.

Preparing the Oil System for Initial Use After Installation

After installation of the turbine, the procedure to be followed to properly clean the oiling system preparatory to a charge of oil should be agreed on by builder's, operator's, and oil supplier's representatives. An inspection of parts may indicate the necessity of hand cleaning some of the parts, if too thick a coating of slushing compound is in evidence; or it may be necessary to remove rust from surfaces if they have been accidentally exposed to the elements; or it may be necessary to remove fly ash, or dirt that may have accumulated during shipment or erection.

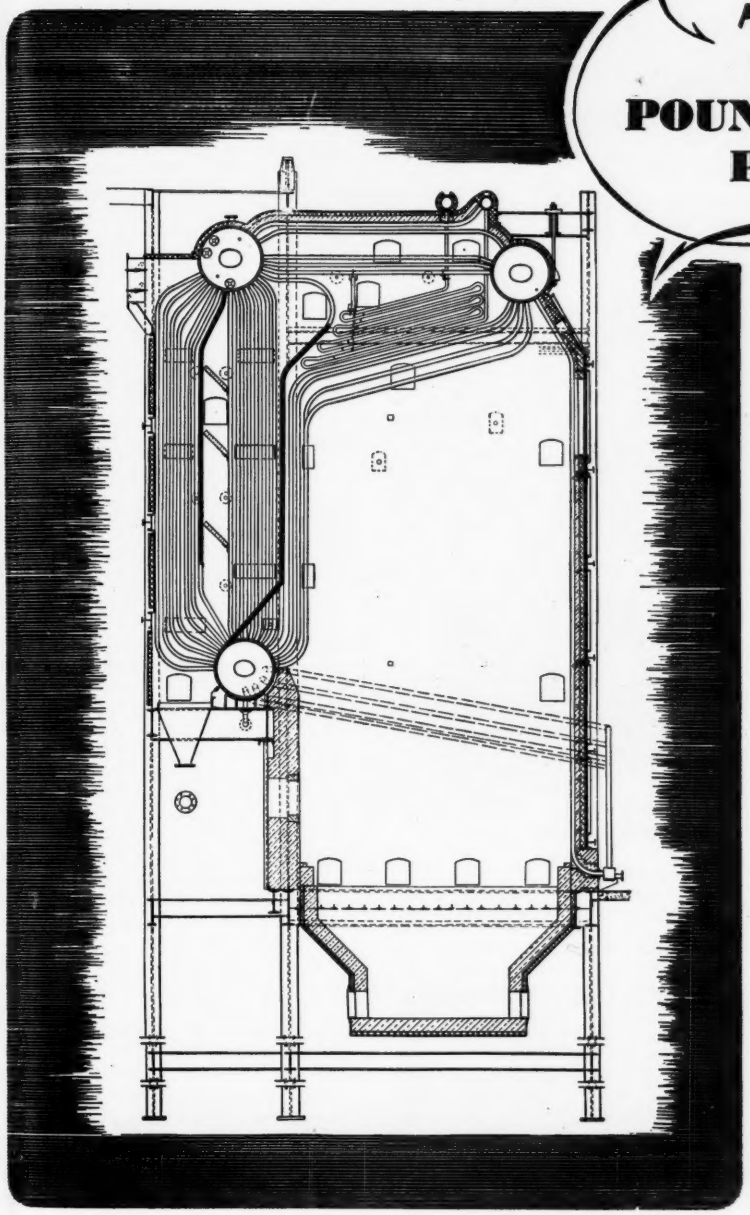
After cleaning, the tank should be charged with a flushing oil, the bearings by-passed, and the flushing operation started.

The flushing oil should either be turbine oil or a lower viscosity oil with the same rust inhibitor as in the turbine oil to be used. The tank should be filled to a level so that the auxiliary oil pump can circulate the flushing oil. The oil should be heated, by suitable means, to a temperature of from 140 to 180 F. This temperature will allow the slushing compounds to become more fluid and will loosen foreign matter in the system more easily. The flushing oil can be heated by passing hot water or 3-to-5-psig saturated steam through the water side of the oil cooler.

Oil should be by-passed through an oil conditioning equipment continuously during this operation. In those stations which do not have an oil conditioning equipment, one should be obtained at least for this operation. A strainer is a very poor substitute for a centrifuge or filter. In fact, it gives one false security since it collects only large particles and lets smaller particles pass through that may be injurious to the bearings and governing mechanism.

The oil conditioning equipment should be cleaned hourly and if nothing collects during two hours, an inspection of the bearings, governing parts, brackets, and other parts should be made. Further flushing should be done, working the governing mechanism to be sure that all contaminants have been removed. After the flushing operation has been completed, the oil should be removed from the system. The tank, pedestals, and bearings should be inspected and cleaned with lintless cloths where necessary. The governing mechanism should be dis-

75,000
POUNDS OF STEAM PER HOUR



Number of Erie City Steam Generators.....1

Pounds of Steam/Hr...75,000

Design Pressure.....450 lbs.

Operating Pressure...400 lbs.

Steam Temperature..650° F.

Heating Surface—
Erie City Boiler
13,000 Sq. Ft.
Erie City Water Walls
880 Sq. Ft.

Final Exit Gas Temp..608° F.

Method of Firing
Blast Furnace Gas

Installed 1948

STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizer • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY
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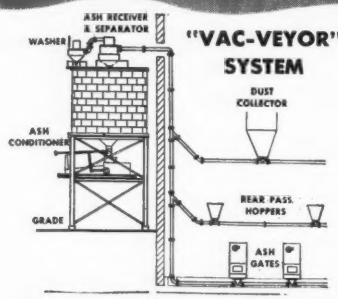
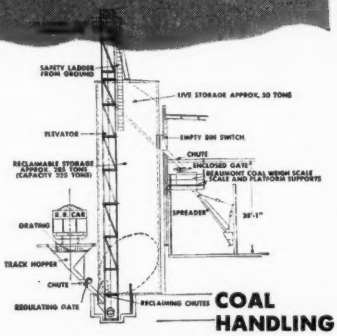
ERIE CITY IRON WORKS • ERIE, PA.

Profits Saved AT EVERY STAGE . . . WITH BEAUMONT COAL & ASH HANDLING EQUIPMENT



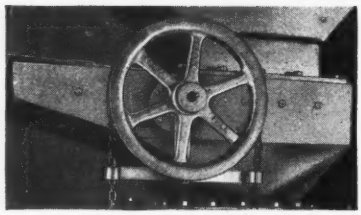
"VAC-VEYOR" SYSTEM

In this system, ashes, siftings, soot and dust are conveyed by pipe from the ash pits, dust collectors, stack, etc., to an ash receiver and separator at the top side of a silo—by means of a vacuum. One man operates the system, keeping your plant cleaner with less labor.



COAL HANDLING

Coal arrives by rail, is dumped into hopper, raised by bucket elevator and discharged either into bunker for immediate use or down chute to yard storage. One operator controls all equipment.

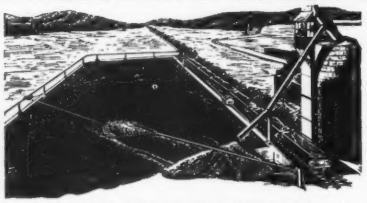


ROLLER BEARING GATE

Incorporating double rack and pinion for granular or powdered materials, these drip-proof self-cleaning gates will not corrode, bend or warp. Material cannot collect in back of gates—these ball bearing gates operate manually or electrically without strain or ramming.

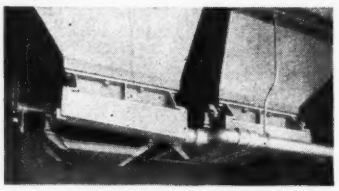
AUTOMATIC WEIGHING SCALE

Accurately weighs coal and similar materials from 1 to 60 tons per hour. Vibrating feeder plate eliminates belts, pulleys and motors. Scale is totally enclosed, dustproof and quiet.



DRAG SCRAPER SYSTEM

Coal is dug evenly with minimum power consumption. Tail blocks can be slung between posts and moved by hand, mechanically moved on I-beam track by tail block car, or suspended from aerial bridge system. One man can operate entire system by remote control.



ASH HOPPERS AND GATES

Steel plate ash hoppers are low cost, rigid, unbreakable, watertight and, when lined with refractory material, resist temperature and erosion. Ash gates are designed for use on stoker and pulverizer ash hoppers where water sealing and draining is essential.

Beaumont engineers design and erect this and associated equipment—*a complete coal and ash handling system.* You save in installation as well as in handling. ONE CONTRACT—ONE RESPONSIBILITY—FOR BULK HANDLING SYSTEMS. Write for more information to:

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Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEM

mantled for the removal of any contaminants.

The turbine oil is now put in the tank, the bearing properly assembled, and the machine closed up. The oil should be circulated through the system by the auxiliary oil pump and oil should be passed through the conditioning equipment. If, after an hour's run, the conditioning equipment picks up no foreign matter, the lubricating system is satisfactory for turbine operation.

On small mechanical-drive sets, necessary precautions should be taken to clean and flush the system to insure its freedom from contaminants. The failure of an auxiliary turbine may close a plant down as easily as a failure of a generating unit.

(To be Continued)

REDUCING BOILER SLUDGE

(Continued from Page 71)

would improve settling of sludge in the sedimentation tank, the feeding of sodium silicate was started. Improvement was noted immediately but by this time the demand for steam had diminished and the effectiveness of the silicate at heavy overloads had yet to be determined.

The test came the following winter. The softener was called upon to deliver more treated water than ever before, the loads averaging 37,500 gph over 24 hr with peak flows approaching 45,000 gph—almost 100 per cent overload. Results were outstanding. The sedimentation-tank effluent was so free from suspended sludge that the operators reported samples collected ahead of the filters to be indistinguishable from samples taken after the filters.

Other dividends are cleaner filters and better filter operation, cleaner boilers, greatly reduced chemical cost, and something that is extremely important, less strain upon the nervous system of the operating men. Today these men report that they would rather get along without phosphate than without silicate.

CASE F

"In the steam drum a white deposit adhered to the drum from the deflecting baffle down to the water level. Also the entire drum surface was covered with a glazed coating.

"Pile (wheelbarrow load) of sludge and fine particles of scale at rear head of mud drum. Top of drum coated with sticky sludge to depth of ½ in. First-pass tubes coated with sludge, some so much that the area of holes therein were only one half cross-sectional area of tubes."

This displeasing report came from a plant operating a 450-psi integral furnace boiler, using raw makeup water having the composition shown in Table V, Column 4. Alkalinity,

Specify! "SPLIT-GLAND" Adjustable Water Gages

BRONZE OR DROP FORGED STEEL CONSTRUCTION WITH STAINLESS STEEL TRIM

Illustrates how easy Flat Glass Units are installed

FIG. 68

Union Joint may also be removed under service while valve is shut off

FOR BOILERS - TANKS AND REFINERY SERVICE etc.

GAGE VALVES MAY BE SET INCLINED OR VERTICAL

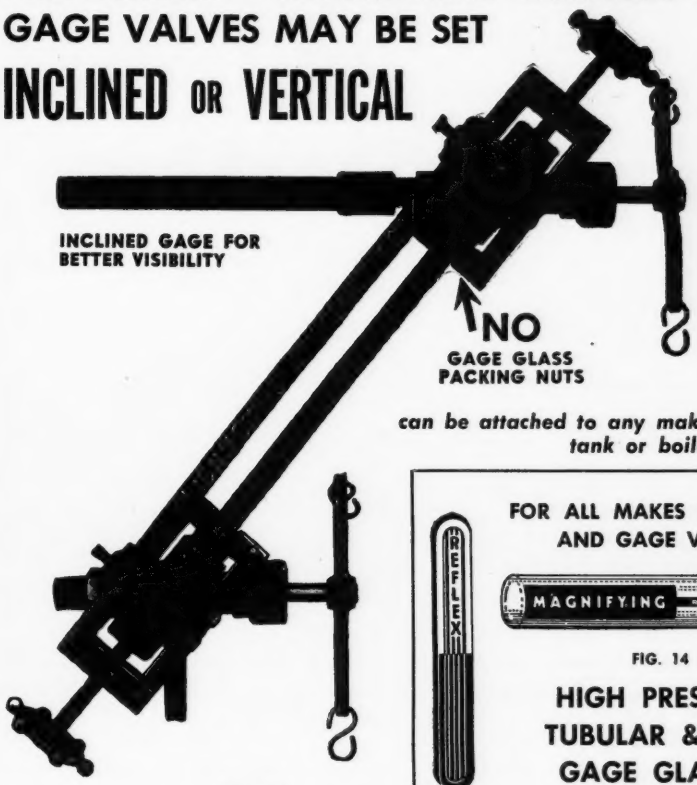

FIG. 2-S

Ernst "C-Clear Thru" Inserts

Recommended to take the place of round glasses when pressures exceed 500 lbs.

FIG. 72

can be attached to any make of water column tank or boiler.

FOR ALL MAKES OF GAGES AND GAGE VALVES

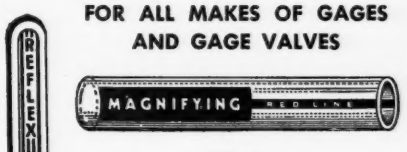

FIG. 14

FIG. 18

HIGH PRESSURE TUBULAR & FLAT GAGE GLASSES ALSO

FIG. 19

STANDARD GAGE AND GAGE VALVES

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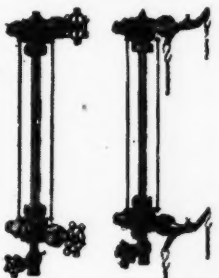

FIG. 76

FIG. 77

Ernst Series 750

HIGH PRESSURE COMPOSITION RUBBER GAGE GLASS GASKETS

ANY SIZE CAN BE FURNISHED TO FIT ALL TYPES PACKING NUT BOXES AND GLASSES

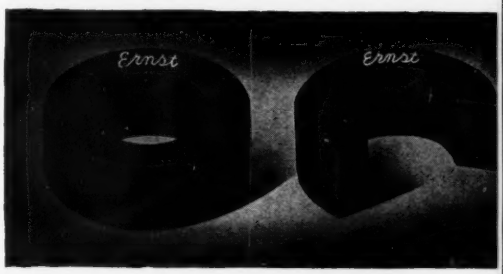

FIG. 22 STANDARD PATTERN, SERIES 750

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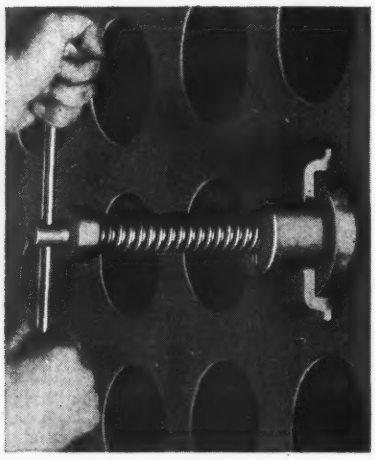

Illustrating ease of operation of Roto Hand-hole Seat Scraper.

If you operate any of the boilers listed below, you can't afford to be without a ROTO Hand-hole Seat Scrapper.

A Pennsylvania manufacturer reports that it formerly took three men 2 to 3 days to clean inside cap seats on a Keeler Boiler header. Now, with a ROTO Hand-hole Seat Scraper, one man does it in four hours, besides doing a better job.

This simple, hand-operated tool is equipped with retractable knives mounted on the end of a revolving spindle having a bearing in a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Write for bulletin and prices.

MAKE OF BOILER	TUBE SIZE	OPENING
Babcock & Wilcox	4"	Oval
B. & W. No. 40 Header	3¼"	Oval
B. & W. No. 41 Header	2"	Oval
B. & W. Superheater	2"	Round
Babcock & Wilcox	4⅛ x 5"	Square
Casey Hedges	4"	Oval
Casey Hedges	3½"	Oval
Combustion Engineer'g	3"	Round
Edge Moore	4"	Oval
Franklin	4"	Round
Geary	4"	Oval
Heine	3½"	Oval
Heine	3½"	Round
Keeler	4"	Round
Keeler	4"	Diamond
Murray	4"	Oval
Murray	3½"	Oval
Oil City	4"	Oval
Oil City	3½"	Oval
Union Iron Works	4"	Pear Shape
Walsh & Widener	4"	Oval

Roto Hand-hole Seat Scraper for Heine Boiler.

ELLIOTT COMPANY-ROTO DIVISION

147 Sussex Avenue Newark 1, N. Y.

phosphate concentration, and total solids concentration of the boiler water had been quite satisfactory, but nevertheless heavy deposits had accumulated at the evaporated surfaces.

Some of the boiler deposits analyzed, Column 1, Table VIII, gave little evidence of lack of silica for combination with magnesium as serpentine. Also the raw water seemed to contain sufficient silica for the magnesium as 4 ppm silica is about right for formation of serpentine with 2 ppm of magnesium. Nevertheless, boiler water silica concentration was relatively low, about 20 ppm, and other deposits analyzed, Column 2, Table VIII, did show enough deficiency of silica to lead to the suspicion that sodium silicate should be used.

Silicate addition was instituted and immediately the sludge content of boiler-water samples increased. This indication of better conditions became a reality when the boiler was inspected after a full six months run with silicate conditioning.

"Steam-drum surfaces had light coating of soft sludge—no glazed material. About a handful of soft mud in front end of this drum and a similar amount of small scale like particles in rear end.

"Mud drum had light coating of soft sludge—very thin film toward front of drum and about ⅛ in. thick toward rear. First pass tubes had ⅛ in. or less of sludge present at mud-drum end, deposit extending only 6 to 8 in. into tubes. Second- and third-pass tubes contained less sludge which extended only short distance into tubes. Less than one pailfull of sludge in rear end of drum."

A later inspection after another six months run revealed the boiler to be even cleaner internally.

CONCLUSION

Experience has proved that another useful tool is available for combating formation of deposits in boilers. It is the much despised silica. By its proper use, under good control, in cases where careful diagnosis dictates the need therefore, sludge accumulation in boilers can be greatly minimized or eliminated, and hot-process, lime-soda softener operation can be improved by better settling in the sedimentation tanks and by improved filter operation.

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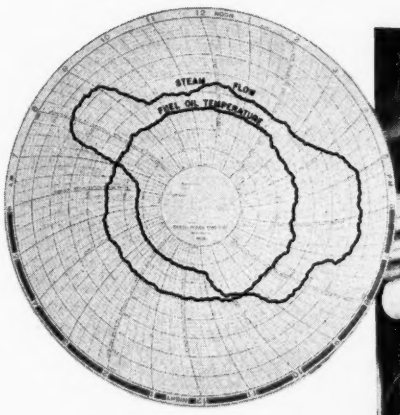

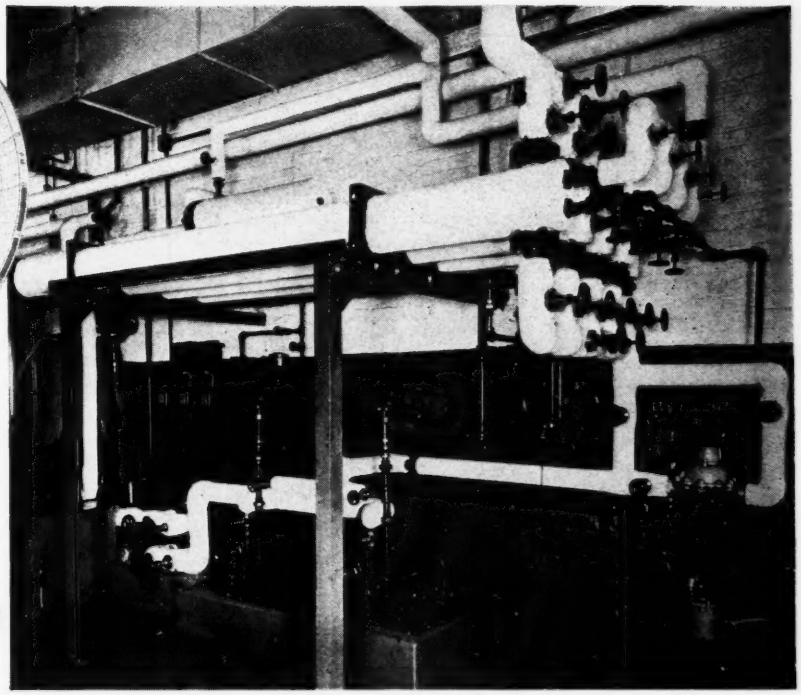

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STOKER FOR WOOD REFUSE

(Continued from page 73)

for the idler. On the drive we spiraled and riveted a layer of ⅜ in. brake lining. One afternoon the chain finally completely failed and by midnight that night we had installed the drum pulleys and the rubber belt. It has been in satisfactory operation ever since. At first it doesn't seem reasonably possible that a smooth rubber belt would work but further study brings forth several interesting facts for consideration.

In the installation shown in Fig. 2 about 16 ft of belt is exposed to the fuel. This fuel weighs approx 9 lb per cu ft, unpacked. This means that the possible weight pressing the belt against the metal partition is 8000 lb! How then, can a ten inch drum pulley pull the belt under such a load. Particularly in view of the fact that rubber slides poorly over flat metal. The answer lies in the flow characteristics of the wood refuse and the peculiar operation of the conveyor.

Why the Rubber Belt Works

Due to the fact that the rubber belt is sliding in a trough, with a half inch to spare on each side, an infinitely small amount of fuel finds its way under the belt in the form of small grains of dust. Occasionally shavings and slightly larger particles can work their way under the belt. These small grains of dust provide a rolling surface between

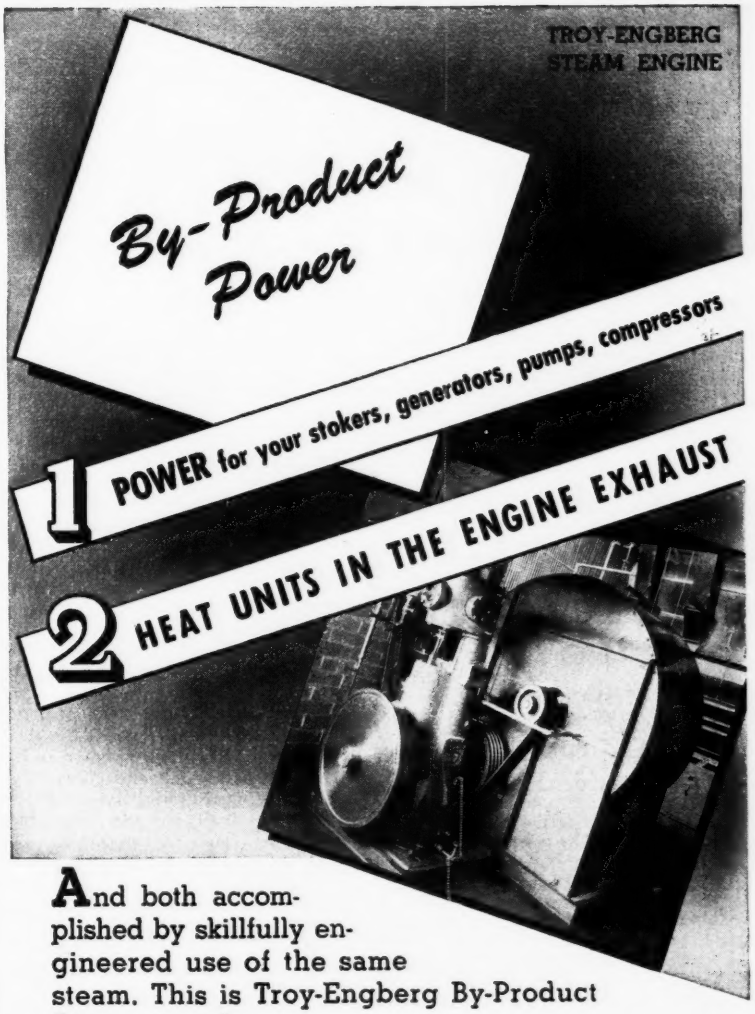
the metal partition and the rubber. They actually act as a lubricant. This fuel slides off the edge of the metal partition and doesn't travel around the drive pulley. It is carried back on the belt and a rubber scraper placed at a 45 deg angle across the belt scrapes off anything that might harm the idlers. The small stuff sticks to the belt, travels around the idlers and thence back between the belt and partition. The material gathered by the scraper might amount to a bucket full in the course of a month.

When a few feet of material is bearing evenly on the belt the power necessary to operate is greater than at any other time. As the wood bin fills up the fuel begins to arch over between the hopper walls and support itself. Then the fuel begins to form circular pockets and feed onto the belt in the same manner that coal flows through an opening. I have observed as many as three round openings that gradually appear on the surface of the fuel. These openings gradually enlarge as fuel feeds from the sides, then they stop and begin to fill up as an arch breaks and the fuel begins to feed from another point along the conveyor belt. This condition usually occurs when there is an even distribution of fuel over the bin area.

At times, principally, when hog refuse is being fed the entire fuel mass will arch over in a perfect inverted V with 45 deg slopes. It is then necessary to start the vibrator and break the arch at some point or rod the fuel. Sometimes air jets can be used. If the hog operator is on the job and feeding a good mixture of fuel then this trouble is a very rare thing. The hog refuse mixes with shavings and other refuse to create a rolling mass that almost never packs.

A good illustration of this rolling mass effect is as follows: I have placed a sheet of paper along with a painted stick on the rear of a moving conveyor belt. The belt carries the paper and the wood under the mass of fuel above it and comes out at the discharge opening virtually in the same position on the belt as when they started. Try this on a chain belt.

One of the outstanding features about the rubber belt is the fact that it doesn't pack the fuel at the discharge opening. It feeds the fuel in the manner shown in Fig. 4. The fuel nearest the discharge is fed first while the belt slides under the fuel in the rear of the wood bin. Gradually a condition is set up whereby the fuel builds up in the back, sometimes at an angle of 60 or 70 deg. The incoming fuel slides swiftly down this slope and flows to the front of the wood vault and out on the conveyor belt. If fuel in excess of the demand is coming in then the average level of the slope rises. If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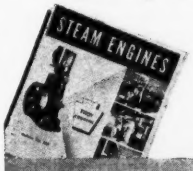

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the demand is in excess of the imput then this slope gradually moves to the rear of the bin. Thus the fuel feeds from the front of the mass at all times. Occasionally, when fuel is fed into the bin with the belt idle a level mass of fuel is created. Then when the belt is started the fuel will feed from the front, the middle, the back, and in random spots.

Rules for Satisfactory Operation

For satisfactory and uninterrupted service it is wise to follow certain rules. Never allow the hog operator to feed in pure veneer. This material enters the wood vault in the form of long slivers that are most difficult to pass through the bin opening. Veneer should be proportioned with solid wood in the form of sticks and fed to the hog. The same holds true for veneered panels. The belt should always be in motion when the fuel is being fed into the wood vault. This establishes and maintains the flow of fuel. When using a vibrator, operate it sparingly and only when the belt is in motion. For the usual wood mixture allow a bin opening of at least 6 in. in height. A reduction of this opening restricts the fuel and will cause it to pack up against the door.

The conveyor design shown in Fig. 1 is satisfactory for the rubber belt but an idler should be added to wrap the belt around the drive pulley as much as possible. This gives the drive pulley a greater traction and the idler automatically compensates for stretch of the belt. It also relieves some of the friction occasioned by the belt dragging along the bottom of the conveyor housing.

The rubber belt wood stokers makes for a very flexible installation. One belt can be used to feed a battery of boilers or one can be installed for each boiler. The stoker can be made to fire any boiler through transfer valves. Two belts can be installed to fire several boilers and so connected that in case of failure of one belt the other will continue to carry the load.

Surprisingly little power is required to drive the rubber belt conveyor. With a 6 by 21-in. opening it is necessary for the drive pulley to operate approximately one revolution per minute to generate power at the rate of 100 kw. This condition results when the fuel is fired into a hrt boiler and the steam is fed to a uniflow engine in good mechanical condition. Nine revolutions per minute will then result in 900 kw of power. This doesn't hold exactly true, of course, but represents an average condition. Less then one horse power is required to move the belt at 9 rpm or three belts at 3 rpm. In fact it takes about as much horsepower to move the reduction gearing as it does the belts. I know of one installation where over 300

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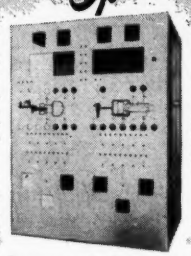

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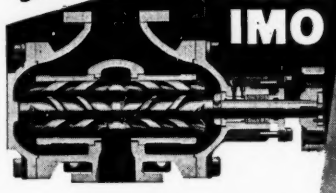

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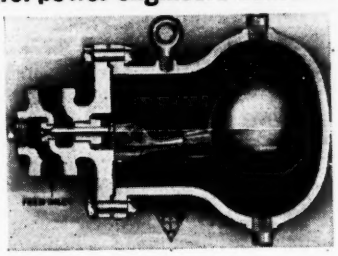

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hp is required to move the fuel to the wood vault. Then 1 hp moves it out at the rate of input.

In a test conducted by the author it was found that during an eight hour period the conveyor belt operated at 9 rpm. At this speed a point on the conveyor belt traveled about 2.5 miles. The fuel level on the belt averaged 5 in. high and 21 in. wide. From these figures about 8000 cu ft of fuel was fed to the boilers. The weight of this fuel was approximately 9 lb per cu ft. The total weight of fuel was then about 72,000 lb. This gives 8 lb per kwh or 0.88 cu ft per kwh. These are round numbers but serve surprisingly well in estimating necessary bin storage and conveyor speed.

The wood refuse at the Stanley Furniture Co. installation constitutes an amazingly good fuel. It contains from 7 to 10 per cent moisture. It either burns in suspension or immediately on the grates leaving no ash and generating no smoke under normal conditions. In fact it is necessary at times to add cinders to create a good fuel bed and keep the wood from burning directly on bare grates. In bringing the boilers from no load to full load it compares favorably with pulverized coal. It is a fickle fuel because the sander dust it contains is explosive. Consequently skilled firemen and up to the minute operation is necessary. The installations with which the author has been connected are, under normal conditions, completely automatic and capable of maintaining pressure charts that might well be the envy of many central stations. Representative hand-firing and automatic-firing pressure charts are shown respectively in Fig. 5 and Fig. 6.

The inexperienced person who attempts his own installation will find wood refuse a most difficult fuel to handle. Up to the wood vault it is easy but from there on in the going is tough. For example; the tie rods, shown by broken lines in Fig. 2 had to be taken out because fuel refused to flow between them. And they were 10 ft apart! The back tie rod was capable of supporting fuel to the very top of the wood vault. However, the problem of feeding wood refuse can be solved as most other problems are solved; with patience.

* * *

Recently the USAF made a very unusual series of photographs. From an altitude of 40,000 feet or higher an experimental plane photographed a continuous path 490 miles wide and 2700 miles long, coast to coast, in an eight hour non-stop flight. The details are such that in the photo of New York City, cars in the streets can be seen through a magnifying glass.

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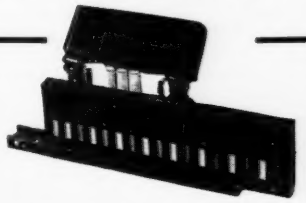

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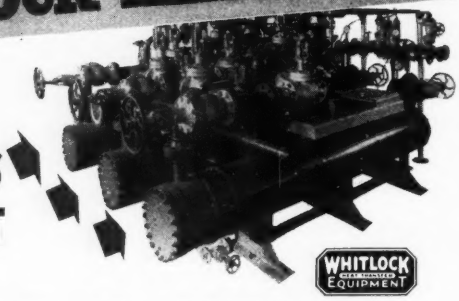

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LITHIUM—HYDROGEN REACTION

(Continued from page 76)

Disclosure of this experiment in 1932, naturally created a great deal of excitement for here was a method, where, with the expenditure of a trivial amount of accelerating power an energy release of 17 million electron volts was obtained. Surely, here was something that would solve all our power problems.

Not All Gravy

Physicists were quick to point out, however, that things were not quite as rosy as they first appeared. While it was true that for every proton that entered a lithium nucleus a hundred times as much energy was released as was used in firing the proton, only a few of the millions of protons fired made direct hits. Viewing the process as a whole, much more energy was expended in accelerating the protons than was released in the reaction.

At the time that these facts were first realized, these limitations were sufficient to discount the value of the experiment from a practical standpoint and it was almost forgotten in the years between 1935 and 1945.

Today, however, after the development of the atomic bomb and our further understanding of nuclear phenomena, the Cockcroft-Walton experiment once again looms extremely in the affairs of man. Aside from the fact that it involves materials that are plentiful compared with uranium, the energy release per unit weight is approximately twice as great as that released in uranium fission. This is not apparent on first inspection; the 17-Mev energy release seems very small compared to the 200-Mev energy release in the fission of uranium, but when the weights involved are taken into consideration, the figures take on an entirely different significance. Uranium fission involves 235 weight units and releases 200 Mev—less than 1 Mev per weight unit. The lithium-hydrogen reaction, on the other hand, with only 8 weight units, yields 17 Mev, or over 2 Mev per weight unit. For this reason, if some method could be developed whereby a chain reaction could be induced in a lithium-hydrogen compound, a much more effective explosive reaction would result.

Until the development of the uranium-fission type bomb, there was little likelihood of ever being able to induce such a chain reaction in a lithium-hydrogen compound. The detonation of a uranium-fission type bomb now, however, offers a possibility of making the lithium-hydrogen reaction work.

As already explained, in the

Cockcroft-Walton experiment, the lithium nuclei have to be hit just right. The lithium nuclei repel the protons with enormous force at close range. With anything but a direct hit, the protons are merely deflected. As a consequence, out of the millions or billions of protons comprising the proton beam, only a few are effective in producing fission. Obviously, what is needed is a method whereby a much greater proportion of the protons are brought in direct collision with lithium nuclei.

It Might Work

To anybody with a basic knowledge of thermodynamics, an obvious way of doing this would be to raise the temperature of a mixture of hydrogen and lithium. When the temperature of a body is raised more kinetic energy is imparted to the atoms and molecules and they move at greater speeds and as a consequence, suffer more violent collisions. Thus, as the temperature of the lithium-hydrogen mixture was raised, the speeds and kinetic energies of the nuclei would increase, and if they were made sufficiently high, fission would take place. Once it was started in a part of the mixture, the enormous energy release would carry the reaction to all parts of the mixture.

In effect, this, of course, is what happens when we kindle a fire. We raise the temperature of a local portion of the fuel by applying the flame of a match, or other source of heat, and the kinetic energy of the molecules in the incandescent gas is, thus, imparted to the molecules of the cool fuel. This increased kinetic energy causes the carbon atoms in the fuel to combine with the oxygen atoms in the air. The resulting reaction is what we call the process of combustion. The energy so released is imparted to adjacent parts of the fuel and so a *chain* reaction is established.

If we could do the same with the hydrogen and lithium atoms, as soon as a fair percentage were moving with a kinetic energy equivalent to that produced by a potential of 75,000 volts, the fission reaction would take place of its own accord. At 75,000 v, when a proton going one way crashed into a lithium atom going the opposite way, the relative speed of the particles would be the required 150,000 volts to produce fission. Once started, the enormous energy release of 17 million electron volts per atom would raise the temperature of the whole mass almost instantly and so involve all the other atoms in the reaction. The reaction would be self sustaining for the minute fraction of a second necessary to explode the whole mass.

Ignition Temperature, 200 million degrees

Offhand, this sounds simple. Actually there are difficulties in the way of attaining the required high

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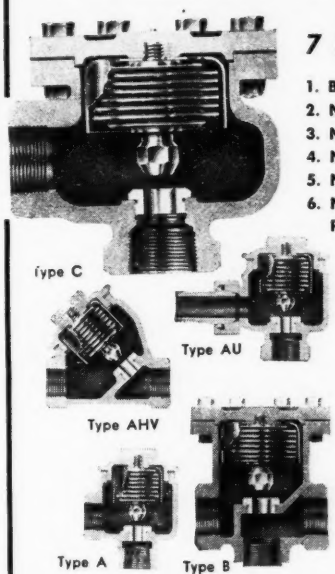

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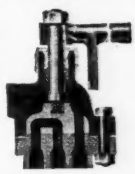

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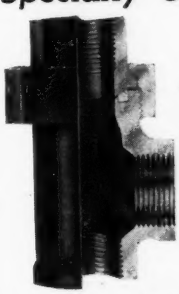

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temperatures, for the temperature corresponding to an energy of 75,000 electron volts is in the neighborhood of 600 million degrees![2] When it is realized that in the flame of the electric arc, the hottest region at our command, the kinetic energy of the atoms approaches but does not quite reach 1 electron volt, it is apparent that temperatures corresponding to 75,000 electron volts would be forever out of our reach, were it not for the uranium-fission reaction in the atomic bomb. The 200 Mev energy release in the uranium bomb, can only be expressed in terms of *thousands of millions of degrees* on the temperature scale. Thus, the explosion of a U-235 type bomb could, if properly applied, heat the lithium-hydrogen mixture to the temperature necessary to start the chain reaction.

It seems simple enough, but the actual construction of a bomb using the lithium-hydrogen reaction with a uranium fission explosion as a primer is no doubt much more difficult than the principle suggests. The principle is clear, however, and unless there are obstacles completely unknown at present which prevent it from working, it is possible, some time in the not too far distant future, that such a bomb will be developed.

One of the reasons why the lithium-hydrogen reaction just described might not work is the fact that this particular reaction is not the only reaction possible with lithium and hydrogen. When lithium is bombarded by hydrogen it is also possible to get

$$_1H^1 + {}_3Li^7 \rightarrow {}_4B^7 + n$$

Here, the result of the bombardment is beryllium and a neutron. This reaction is endothermic, approximately 2 Mv kinetic being needed in the protons for the reaction to proceed. The excess energy of the incident protons over the 2 Mv threshold will turn in greatest part into kinetic energy of the neutrons.

As a matter of fact if lithium is bombarded by hydrogen, a great number of reactions are observed due to the fact that lithium has two isotopes, namely Li^6 and Li^7 and these isotopes react in various ways with the hydrogen nuclei. Of course, the Li^6 and Li^7 could be separated but this would be expensive and would offset the advantages the use of lithium would have if it could be used as found in nature. Actually, Li^7 is much more abundant than Li^6, the former being present to the extent of 92.5 per cent in natural lithium against only 7.5 per cent for Li^6.

As explained, in the Cockcroft-Walton experiment, only 150,000 volts are necessary to accelerate the protons. Hence, if the kinetic energy of the protons could be kept down

[2] The temperature on the absolute or Kelvin (K) scale for any Mev value can easily be calculated by the formula

$$T = 7.8 \times 10^9 E$$

when T = deg K
E = Mev

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to a value below the 2 Mv threshold needed for the neutron reaction by the use of a moderator of some kind, the lithium-hydrogen reaction might be made to work.

The most suitable material for use in such a bomb would be lithium hydride. LiH. This material sells for around $12.00 per pound and contains lithium and hydrogen atoms in the proper proportion. If these atoms can be accelerated to the required speed by the kinetic energy of the U-235 fission reaction, we might have the super-atomic bomb the writers of the Sunday supplements like to imagine. Such bombs would make the present atomic bombs little more than fire crackers by comparison.

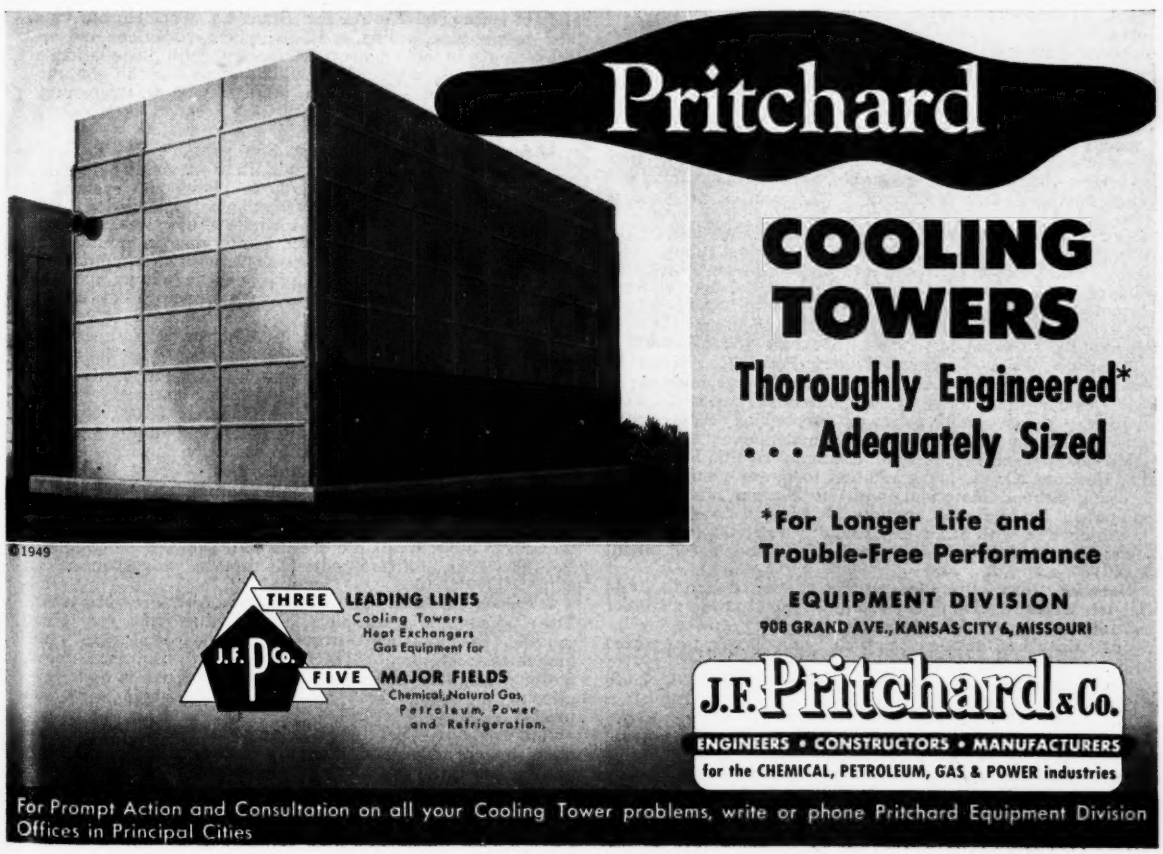
Figure 3 attempts to show how this principle might be used in the design of a lithium hydrogen type of atomic bomb. Here, a mass of lithium-hydride surrounds the elements of a uranium-fission type of atomic bomb. This, as will be noted, consists of a spherical mass of U-235 (or plutonium) with one sector of the sphere removed and fitted to the end of a projectile. The removal of this sector brings the uranium mass below the critical volume needed to sustain a chain reaction. By shooting the spherical sector into the sub-critical remnant of the sphere at high speed, a super-critical mass is obtained and it explodes violently. The fission fragments have kinetic energies equivalent to temperatures of thousands of millions of degrees. These energies are then imparted to the hydrogen and lithium nuclei in the surrounding lithium-hydride mixture and thus, the mixture is raised to the *ignition* temperature.

On a diagram, as in Fig. 3, it seems simple enough but it probably is too simple. The nuclear physicists who have been working on these problems, no doubt, know a great deal more about these reactions than has appeared in *released* literature and only time will tell whether reactions such as these can be made to work.

Little has been said about the lithium-hydrogen reaction in official reports of nuclear research, but all these facts have been known by scientists throughout the world for many years, and it would be strange if the possibilities of this, and other similar light element reactions, were not being investigated and exploited to the utmost.

Attractive as the possibilities of this reaction seem in regard to the development of a super-atomic weapon, it offers little hope of usefulness in the field of atomic power development because of the high temperatures involved and the explosive nature of the reaction. True, basically, the uranium fission reaction also is characterized by extremely high temperatures but uranium fission can be brought about by slow moving neutrons (thermal neutrons) and this implies a significant difference. By providing suitable moderators, neutrons can be slowed down to any desired degree and this makes it possible to control the uranium fission reaction. Uranium fission can be induced by neutrons having energies as low as 5 electron volts. In the Cockcroft-Walton experiment it is necessary that a proton hit a lithium nucleus with an energy of 150,000 electron volts and very few—practically none—hit. On successful hits there is a profit in terms of energy but the percentage of successful hits is so low that the overall result is a net loss. In the uranium reaction, however, the slow neutrons drift, and bounce around. If they fail to produce fission in one atom they bounce against other atoms and sooner or later, they make real hits. This fact makes it possible to build *reactors* in which the reaction can be controlled and allowed to proceed at any rate desired.

This is not possible with the lithium-hydrogen reaction. In this case, the particle producing fission must have an energy of at least 75,000 electron volts and this means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that the reaction can take place as a chain reaction only at temperatures of hundreds of millions of degrees. Obviously, there can be no containers for temperatures of this order and for that reason this reaction cannot be controlled and used to develop power. This limitation does not stand in the way of utilizing the lithium-hydrogen reaction in an atomic bomb. Indeed, the very fact that the high temperatures are required, give it its great value in the field of atomic weapons.

It would be little less than negligent on the part of those responsible for our long range policies in regard to national defense to disregard the possibility of developing atomic bombs of this type. Whatever our own position in atomic science, whatever our progress and achievements, we must not discount the efforts and possible achievements of other nations. Since the Soviet Union is the great enigma in the atomic field, since no reliable or official information is available regarding the state of atomic development in the Soviet Union, we have no alternative but to assume that their scientists are working on all of these problems with the same zeal as we are. Only recently a report attributed to Professor Heisenburg stated that the Russians were actually producing atomic weapons. Whether they are producing them at the present moment or not is of little consequence. What is important, is that they *will* produce them. With the Smythe report to guide them and considering what is, and has been, known by scientists all over the world, the Russians are as certain to produce the atomic bomb as we were, once the basic principle of fission was understood. Whatever the Russians may lack in what is usually termed technical know-how, their science is of a high order. It was a Russian scientist, V. Veksler, who developed the synchrotron in Russia parallel with its development by McMillan[3] in this country.

If both the western democracies and the Soviet Union succeed in developing atomic bombs of the uranium-primer lithium-hydrogen type, it will avail us but little in the case of war to have elaborate radar warning screens. For, when we see the atomic powered rockets, coming, more than likely it will be too late. Let there be no doubt about it, this *is* something that could bring about the end, or at least, the twilight of civilization. As Karl Darrow put it in a lecture recently, we speak of an awful headache, a dreadful cold and an appalling storm but now when something really awful and dreadful and frightful comes along, all these words have been devaluated and have no terror in them to apply to this most fundamental of all forces.

[3] Recent Developments in High Energy Physics—Power Generation, Jan., 1948, p. 91.

POWER PLANT Construction News

Mobile, Ala.—Hollingsworth & Whitney Co., Magazine Point, Mobile, plans extensions in power plant at Chickasaw pulp and paper mill, with installation of additional equipment, in connection with expansion program at mill for large increased output. Several new units will be built for sulphate pulp mill and paper-making department, respectively. Entire project is reported to cost close to $13,000,000.

Antioch, Calif.—Pacific Gas & Electric Co., 245 Market St., San Francisco, Calif., is completing plans for new steam-electric power plant near Antioch, to be equipped for a capacity of 300,000-kw. Proposed to begin work on foundations at early date. Cost reported close to $20,000,000, with switching stations, power substations, transmission lines and other facilities. This is part of 1949 expansion program of company.

Los Angeles, Calif.—American Brass Co., 414 Meadow St., Waterbury, Conn., brass, bronze and other metal tubing, rods, sheets, etc., plans boiler house at proposed new branch on 45-acre tract of land at Garfield Blvd. and Compton Ave., Paramount, near Los Angeles, recently acquired. Entire project will comprise several production buildings and will represent a reported investment in excess of $3,000,000.

Riverside, Calif.—California Electric Power Co., Riverside, has authorized an expansion and improvement program in plants and system, to be carried out during next 24 mos., including power stations, power substations, transmission lines and other facilities. Cost estimated over $10,000,000.

Mansfield, Conn.—State Dept. of Mental Health, State Capitol, Hartford, Conn., plans addition to power plant at State Training School, Mansfield, with installation of additional equipment for increased capacity. Work will be carried out in conjunction with other expansion at institution, including several new buildings, entire project reported to cost about $2,200,000.

Norwich, Conn.—State Department of Mental Health, State Capitol, Hartford, Conn., is considering new power plant for central-heating service, mechanical laundry and miscellaneous utility buildings at Norwich State Hospital, reported to cost close to $1,250,000.

Jacksonville, Fla.—Lloyd A. Fry Roofing Co., 5818 South Archer Rd., Summit, Chicago, Ill., prepared roofing, plans boiler house at proposed new plant on St. Johns River, Jacksonville, where site has been secured. It will comprise several buildings, reported to cost over $1,700,000, with equipment. Work will begin soon.

Miami, Fla.—Florida Power & Light Co., 25 South 2nd St., is considering new generating station in vicinity of Green Cove Spring, Clay County, where site is being selected, reported to cost close to $10,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment.

Chicago, Ill.—E. H. Sargent & Co., Inc., 155 East Superior St., Chicago, laboratory and chemical equipment, scientific instruments, etc., plans installation of boiler plant in new one-story factory on local site on West Foster Ave., near Cicero Ave., totaling about 115,000 sq ft floor space. Entire project is estimated to cost close to $1,000,000. Olsen & Urbain, 5 South Wabash Ave., Chicago, are architects.

Augusta, Me.—Central Maine Power Co., 9 Green St., Augusta, has arranged budget of about $9,800,000, for extensions and improvements in plants and system during present year, including generating stations, power substations, transmission and distributing lines, and other operating facilities.

Port Huron, Mich.—Mueller Brass Co., Port Huron, brass and copper pipe, tubing, rods, etc., plans extensions and improvements in boiler plant at factory, with installation of additional equipment. Work will be carried out in conjunction with new addition to tube mill, 160 x 740 ft, entire project to cost approximately $2,000,000. Program is scheduled to be carried out this year.

Minneapolis, Minn.—Northern States Power Co., 15 South 5th St., Minneapolis, has arranged fund of about $15,400,000 for expansion and improvements in plants and system, of which approximately $13,500,000 will be expended in 1949 and remainder in 1950. Work includes a new steam-electric generating station at Red Wing, Minn., now in progress, to be equipped for initial capacity of 23,000-kw, scheduled for completion next fall; and a hydroelectric power plant on Chippewa River, Holcombe, Wis., with capacity of 34,000-kw, expected to be ready for service in summer of 1950. Also power substations, extensions of transmission lines and other facilities.

Natchez, Miss.—Mississippi Power & Light Co., Jackson, Miss., plans new steam-electric generating station in vicinity of Natchez, reported to cost approximately $8,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment, including extensions in transmission lines.

Marietta, Ohio—Electro Metallurgical Co., 30 East 42nd St., New York, ferro-alloys, metals, etc., plans new steam-electric power plant on site near Marietta, to be used for service in connection with new factory to be constructed in that area. Station will use coal as fuel and will be equipped for large output. Entire project is reported to cost in excess of $3,500,000.

Johnsonville, Tenn.—Tennessee Valley Authority, Nashville, Tenn., plans new steam-electric generating station at Johnsonville, to supplement hydroelectric power service, estimated to cost about $54,000,000, with transmission lines, power substations and other facilities. Congress is now considering an initial fund of $2,500,000, to begin work on project.

Andrews, Tex.—Phillips Petroleum Co., Bartlesville, Okla., plans boiler house and pumping station at proposed new natural gasoline plant in vicinity of Andrews. A compressor plant will be built, with pipe lines for natural gas transmission. Entire project will comprise several large units for processing and production, and is reported to cost over $2,000,000. Work will proceed at early date.

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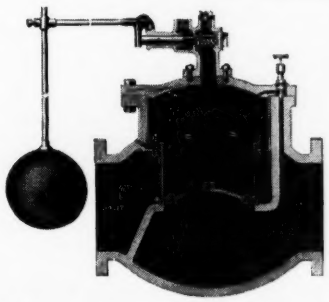
Cold Water **Valves**



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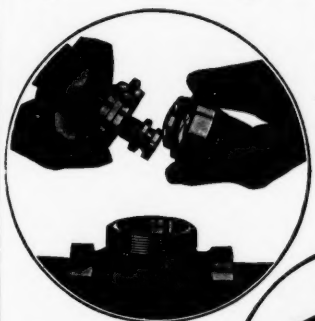

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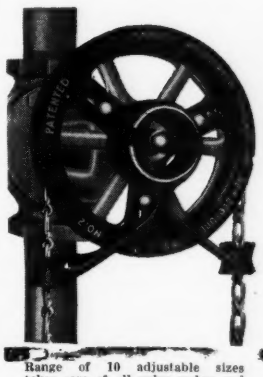

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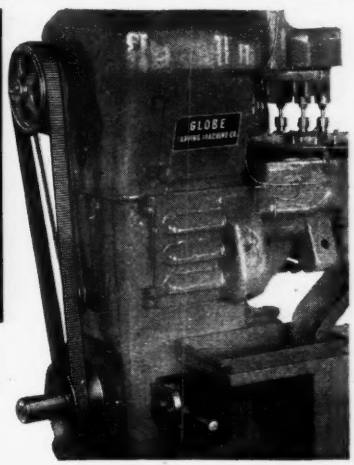

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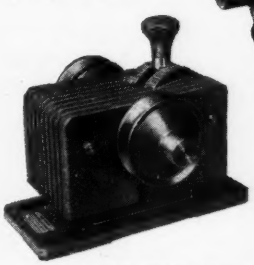

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with the "CUSHIONED CLOSING" of

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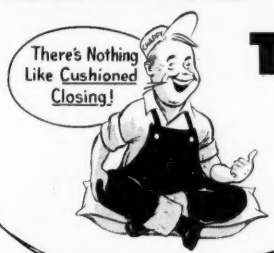
TILTING DISC CHECK VALVES



Chapman Tilting Disc Check Valves *work with . . . not against . . . the stream.* As a result, destructive pipe line stresses are practically eliminated. Head losses, as compared with conventional type check valves, are reduced 65% to 80%.

This balanced disc rides smoothly on the flow. It lifts away easily when opening . . . closes quickly and quietly. There is no rubbing on the seat . . . no slamming. Hinge pins, seats and bearings wear far longer.

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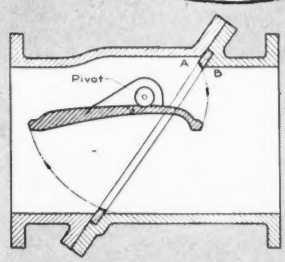

Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

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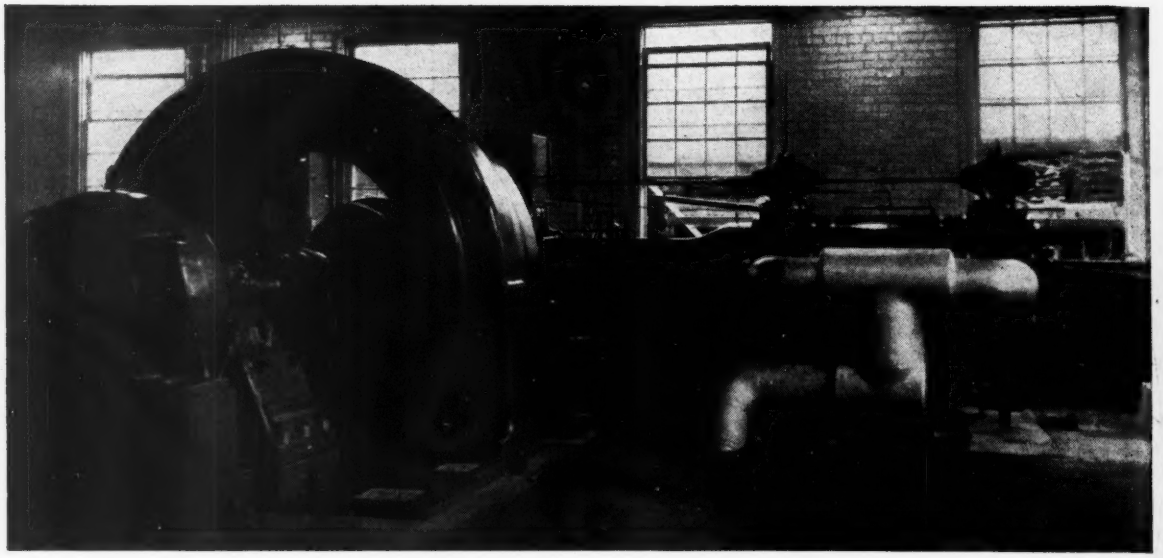
steam-tight rings for
FULL POWER



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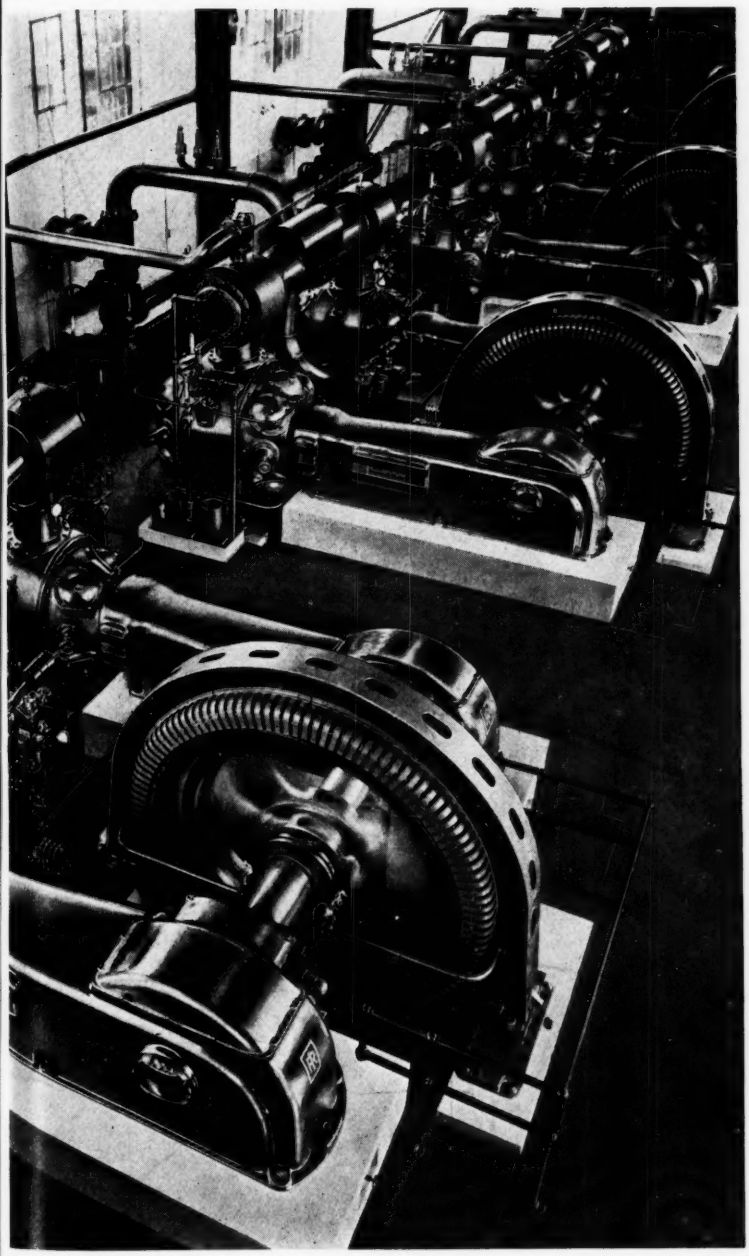

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COVER: Four 700-hp synchronous-motor-driven air compressors generating air power for operating rock drills and other air-operated equipment in an Eastern magnetite iron mine. (Ingersoll-Rand photo).

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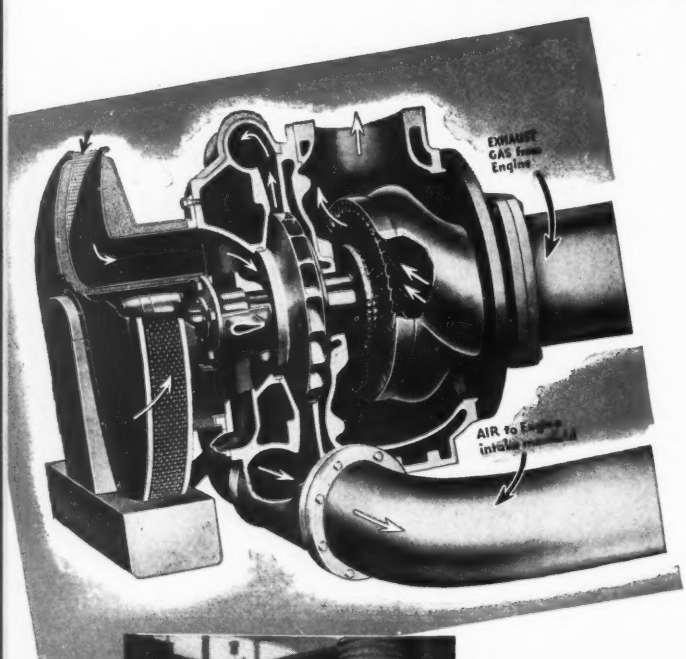

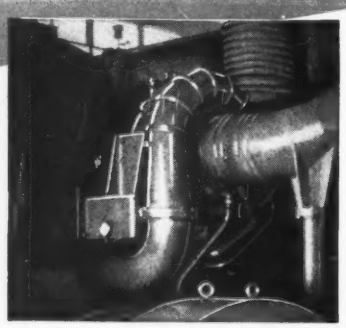

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